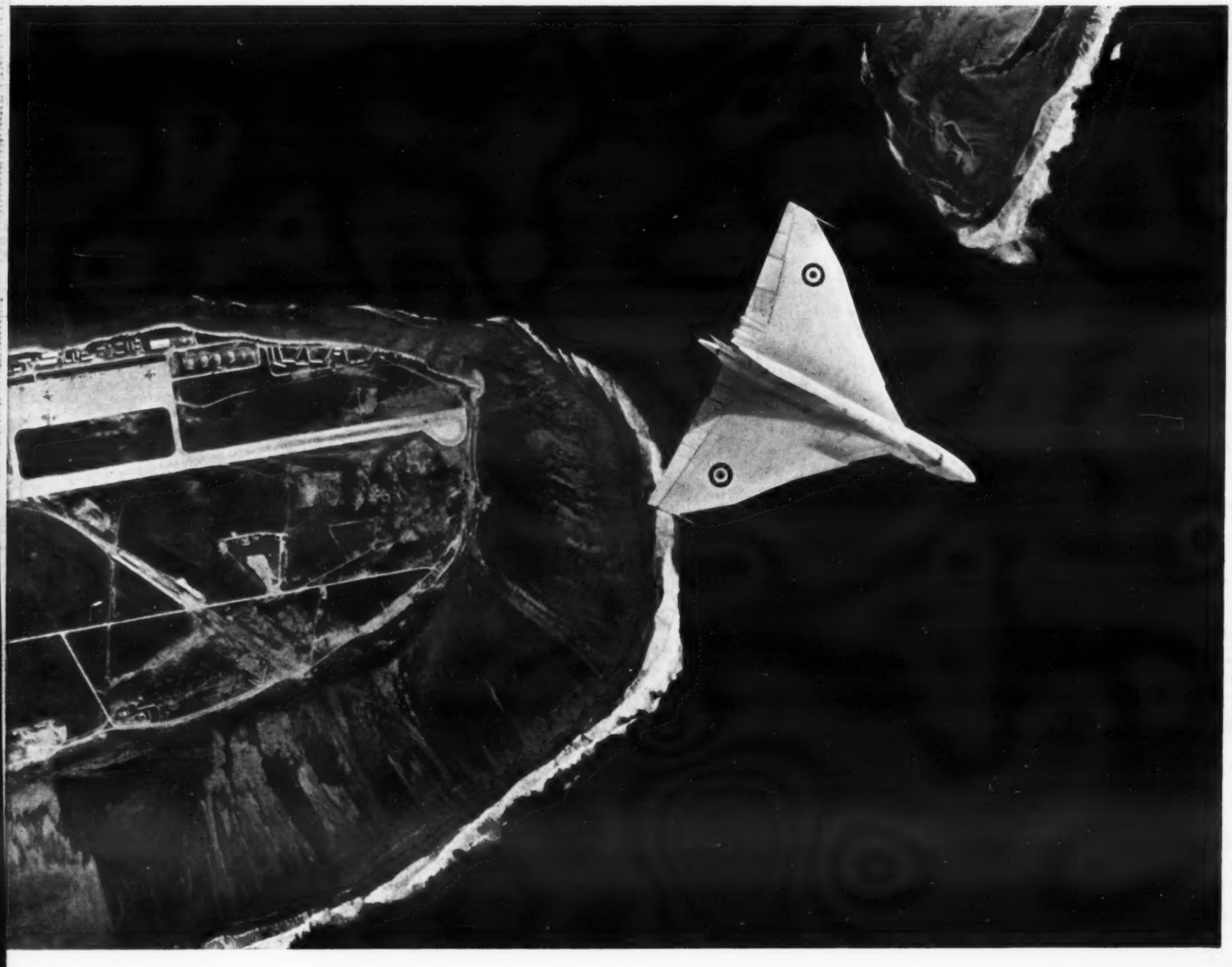
INTERAVIA

World Review of Aviation and Astronautics
with Electronics Supplement



Price of this issue —

U.S.A.:	$ 1.00
Canada:	$ 1.00
British Isles:	4/6
South Africa:	6 s.
Rhodesia:	6/6
Switzerland:	Fr. 3.50
Germany:	DM 3.50
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VOLUME XV

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Background to Farnborough 1960

SAS Plays Host to IATA • Saab Draken Weapons System

No. 9 / 1960

Convair's 880, the only American-built jet airliner with all first-class seating, brings you an entirely new travel concept in speed, splendor and spectacular performance! With the 880 you're flying on the fastest, newest and most advanced jet passenger plane in the world!

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Volume XV

INTERAVIA

September 1960

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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Front cover : In the early morning light a *Vulcan* leaves the reef-fringed island of Gan on its way over the Indian Ocean to Malaya.

Among the obligations of an airline the comfort of passengers is second only to their safety.

Sabena is proud of the achievement of one of its engineers, Mr. François Braun, who has designed a new type of seat. This has been built in the company's workshops and put through the most rigorous tests; it increases not only the comfort of travellers, but also their safety. The Braun seat automatically assumes a horizontal position when subjected to a given deceleration, particularly in the case of a hard landing.

The Belgian Aeronautical Administration has recently certificated this new seat. During laboratory tests at Haren, near Brussels, a resistance to deceleration stress of 20 g was recorded, corresponding to 3,750 lb per passenger.

The Braun seat, which will equip the first-class cabins of Sabena's Boeing Intercontinentals, has also aroused the interest of Air France, which has ordered seven lots of 36 seats.

The USAF is also considering using the Braun seat, which it will shortly be subjecting to dynamic tests.

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Distributors :

Argentine York Agency, Tacuari 178, Buenos Aires
Austria Morawa & Co., Wollzeile 11, Vienna I
Canada Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Gordon & Gotch (Canada) Ltd., 244 Bay Street, Toronto I.
Cuba Tano Gómez, Prado 412, La Habana
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U. S. A. Eastern News Distributors, Inc., 306 West 11th Street, New York 14, N. Y.
Venezuela Michel Frochot, Apartado 2.648, Caracas

Advertising Department, Publishing and Editorial Offices, Subscription Department :
Interavia S.A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions : U.S.A. and Canada, U.S. $9.00; United Kingdom and Eire, £2.12.6; Commonwealth, £2.12.6; Switzerland, 32.— fr.; Austria, 190.— sch.; Belgium, 370.— fr.; Denmark, 55.— kr.; France, 42.— N.F.; Germany, 32.— DM; Holland, 28.— fl.; Italy, 4640.— L. it.; Japan, U.S. $9.00; Latin American countries, U.S. $9.00; Norway, 57.— kr.; Spain, 450.— pts; Sweden, 40.— kr. All other countries, U.S. $9.00.
Second class postage paid at New York, N. Y.

Appears Monthly in Four Editions : English, French, Spanish and German

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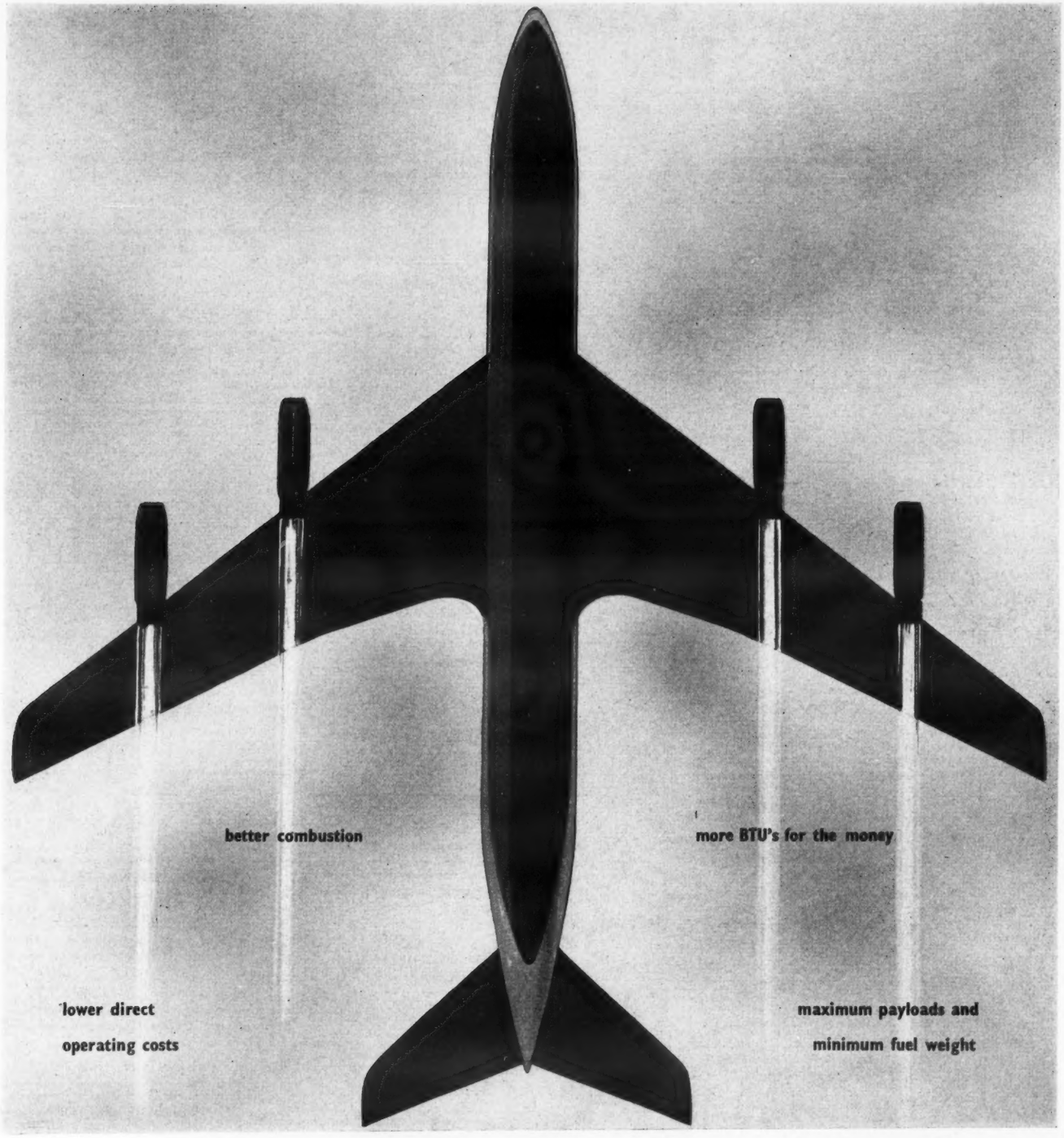

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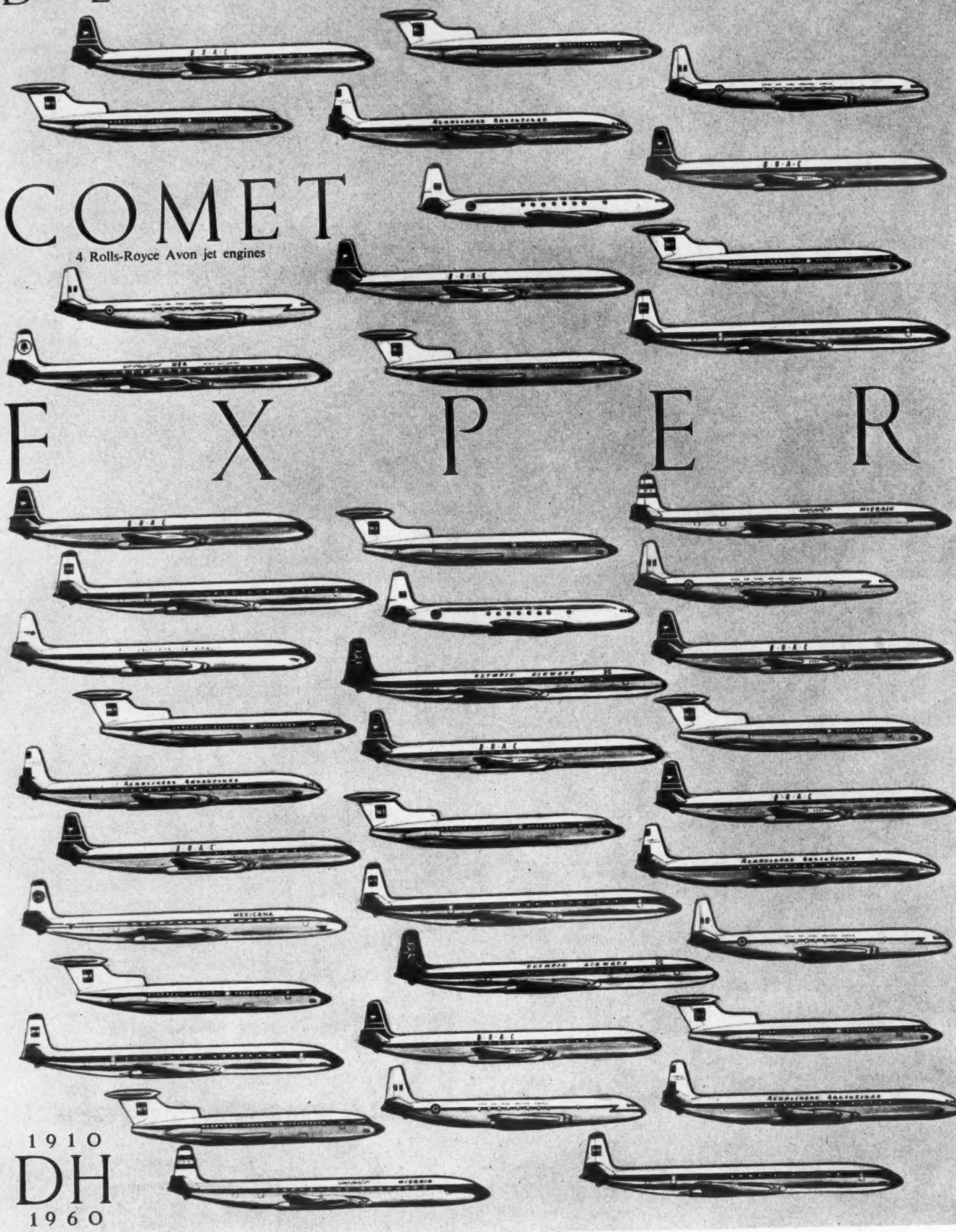

COMET

4 Rolls-Royce Avon jet engines

EXPER

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D'H AIRCRAFT
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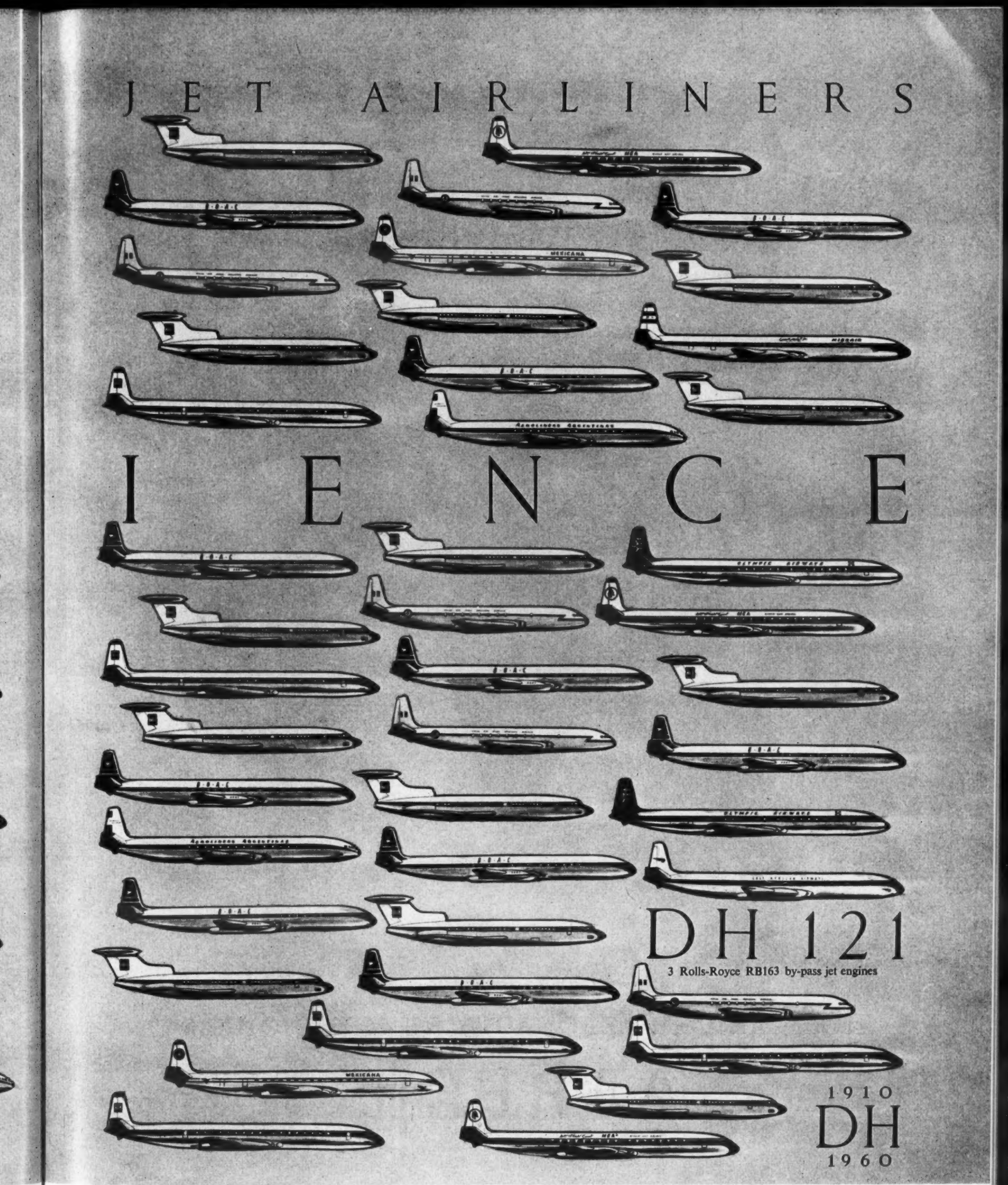

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SAAB J 35 DRAKEN

Western Europe's most modern fighter in service

READY FOR ACTION

The SAAB J 35A Draken has gone into regular service with the Royal Swedish Air Force. Today the Draken is Western Europe's most modern fighter in service ! The Swedish Air Force and Swedish aircraft industry thus repeat their feat of 1951 when the SAAB J 29 " Flying Barrel " went into service as the first swept wing fighter in Western Europe, and the most modern West European aircraft of that time.

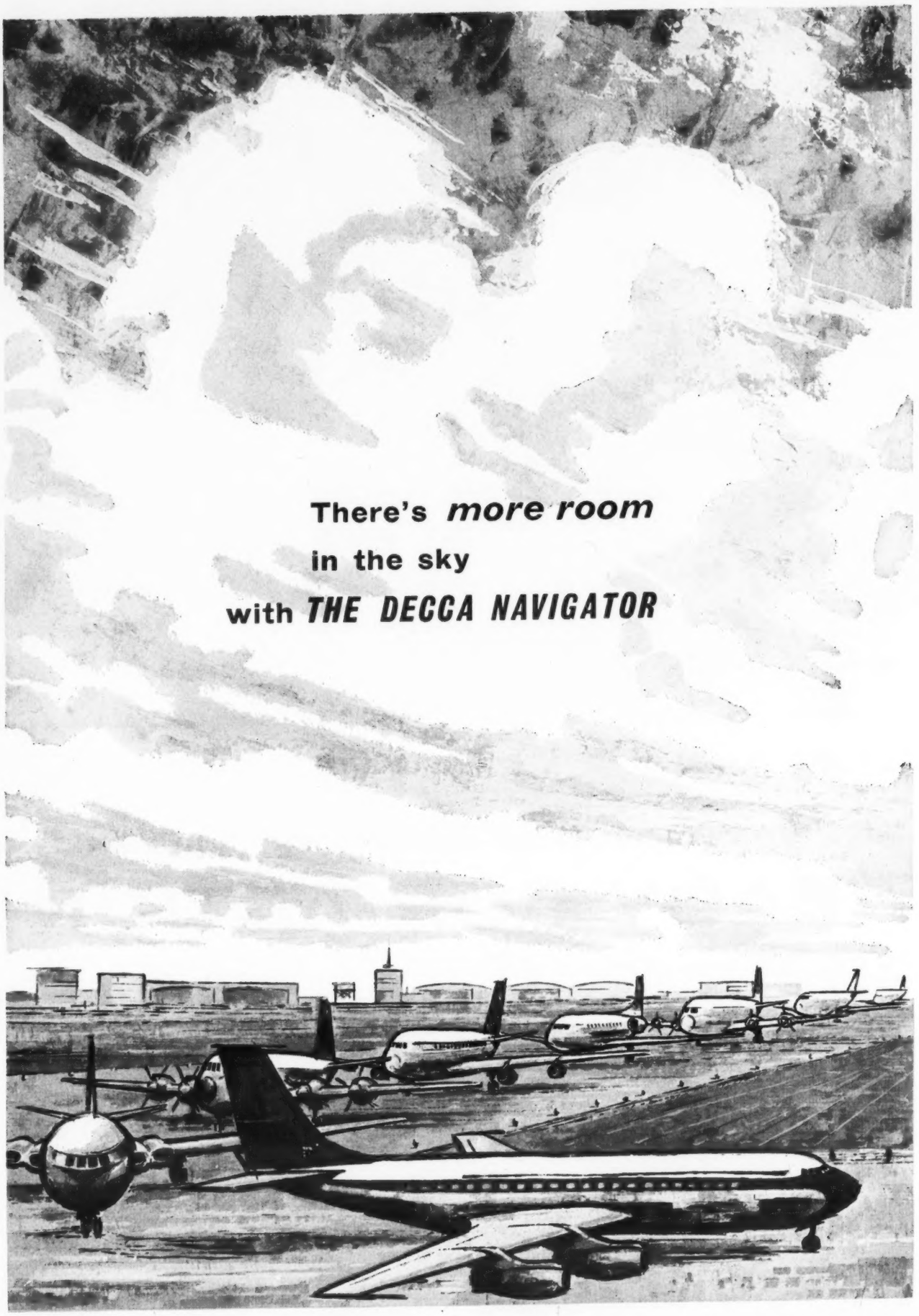
A SAAB J 35A Draken unit recently played a most successful part in a major air defence manoeuvre. This was a realistic test of the Draken in air defence, designed to provide control and ground service experience of the type acquired under active service conditions. Time from take-off order to aircraft airborne was remarkably short. In brief, the Draken gave convincing proof of its ability to save the seconds so precious in modern air defence.

The DRAKEN 35B — with a more powerful Rolls Royce engine and other improvements — has a top speed of Mach 2+ and an initial climb rate of 50,000 ft. per minute. The Draken 35B is equipped with advanced collision-course fire control and can alternatively carry rocket and guided missile fighter armament or heavy attack armament — rockets or bombs.

The DRAKEN has full radar and navigation equipment for all-weather operation. Excellent handling qualities at low speed allow using even small shut-in airfields.

The DRAKEN has been designed and developed by SAAB — a modern enterprise with 9,000 employees and more than 10 years of experience in large-scale production of high-speed jet aircraft.

SVENSKA AEROPLAN AKTIEBOLAGET *(SAAB AIRCRAFT COMPANY)* · LINKÖPING · SWEDEN


There's *more room*
in the sky
with *THE DECCA NAVIGATOR*

INTERAVIA
AIR LETTER
reports...*

The National Aeronautics and Space Administration has named a variety of proposed new satellite, lunar and interplanetary missions which will use the forthcoming *Atlas-Agena-B*, *Centaur* and *Saturn* boosters. These include:

— *Aeros:* a meteorological satellite which might be placed in a stationary (23,000-mile) orbit in 1964;

— *Surveyor:* a lunar soft-landing spacecraft based on *Centaur* and capable of depositing a stationary payload of 100-300 lb on the moon.

— *Prospector:* a lunar soft-landing craft based on *Saturn* which will be capable of placing a 50-mile range mobile vehicle on the moon.

— *Mariner*: a Mars/Venus space probe probably utilizing *Centaur*.

— *Voyager:* a sophisticated spacecraft based on *Saturn* which could place payloads in orbit around Mars and Venus and eject instrumented capsules for atmospheric entry and possible landing on these planets.

— *Apollo* is a space vehicle designed to carry a 3-man crew on extended space journeys including circumlunar flight by 1970. The vehicle will consist of three basic "modules," a command and control section, a mission module and a propulsion module. Contracts for design, engineering and fabrication are expected to be awarded in fiscal 1962. The booster vehicle will be a *Saturn C-1* or *C-2*. Research and development work and prototype flights will take place between 1962 and 1965, with *Atlas-Agena-B* being used as launch vehicle for these tests.

●

The first unmanned Mercury launch test carried out from Cape Canaveral on July 29th with the aid of an *Atlas*, was a failure, as the *Atlas* exploded 65 seconds after take-off. The capsule sections were found 5 miles offshore.

●

Douglas Aircraft Company expects to receive contracts totalling about $600 million for the production of 120 carrier-based *Missileer* aircraft (cf. page 1122). Each aircraft is expected to cost roughly $5 million to produce and the first of several development contracts is expected before the end of the year.

●

Discoverer XIII was successfully launched into orbit from Vandenberg AFB, California, on August 10th and the instrument capsule was recovered by the crew of a Navy helicopter some 29 hours later. The capsule, which was ejected after the *Discoverer XIII's* seventeenth orbit, weighed 300 lb and had a diameter of 33 inches, and was fitted with flotation apparatus; ejected at 23:15 hours GMT on August 11th when the satellite was over Alaska it came down in the Pacific about 300 miles from Honolulu. This is the first time a capsule has been recovered during the test programme. Another *Discoverer* (XIV) was launched by means of a *Thor-Agena* from Vandenberg, Calif., on August 18th. The capsule was successfully recaptured by an aircraft during descent. A further one — to be launched in about a month — will be fitted with a recoverable ejection capsule containing a small chimpanzee in addition to the normal instrumentation.

●

An Echo I inflatable communications and TV satellite was successfully launched on August 12th, following the failure of the first launching on May 13th. The second satellite which, like the first, had a diameter of 100 ft, was launched from Cape Canaveral at 09:40 GMT by a *Thor-Able* three-stage booster and entered its prescribed orbit according to plan. The satellite weighed about 140 lb; although it orbited the earth at a distance of about 10,000 miles in a period of 121.6 minutes, its life was expected to be relatively short—one or two weeks at the outside.

Echo is a so-called "passive" satellite, carrying no radio equipment but serving merely as a reflector; it has already proved its worth in this capacity and as a radio and TV relay station. Later, "active" communications satellites are to be placed in orbit around the earth; these will carry equipment to record a transmission and retransmit it after a time lapse.

The *Thor-Delta* booster which put *Echo I* into orbit, is a three-stage rocket about 92 ft long and with a launching weight of 112,000 lb. First stage: Douglas *Thor* weighing 100,000 lb; thrust 150,000 lb. Second stage: modified *Vanguard* second stage weighing over 4,000 lb; thrust 7,500 lb. Third stage: solid-propellant rocket motor weighing 500 lb; thrust 3,000 lb. Powered phase of the first stage is approx. 160 seconds; the second stage burns for 115 seconds; the third stage for about 40 seconds.

●

A North American X-15 rocket research aircraft, flown by USAF Major Robert M. White, reached a record height of 136,500 ft on August 12th, thus exceeding the altitude of 126,000 ft reached by a Bell X-2 experimental aircraft on September 7th, 1956. During his record flight White went into a 51-degree climb after release from the Boeing B-52 mother aircraft; maximum speed was 1,700 mph. On August 4th an X-15 reached a record speed 2,196 mph.

(continued on p. 1008)

* Interavia Air Letter is a daily international news digest published in English, French ("Courrier Aérien") and German ("Luft-Post"). All rights reserved.

From the Farnborough Catalogue

Airmed Limited, Harlow: *Airlite* headsets with oxygen masks; *Simplite* headsets with miniature microphone; *Unilite* single earpiece headsets. *Airlite* headsets are standard equipment on BOAC's *Comet 4s, Britannias* and Boeing 707s, SAS's *Caravelles* and DC-8s, the *Comet 4s* of Aerolíneas Argentinas and Compañía Mexicana de Aviación, and Olympic Airways' *Comet 4Bs*.

Air Trainers Link Ltd., Aylesbury: All kinds of flight simulators for civil and military aircraft.

Alvis Ltd., Coventry: *Salamander* chassis for unrestricted use in all types of terrain. The *Salamander* is the basis for crash tenders (fitted with Pyrene or Tecalemit fire fighting equipment), as used by the RAF, the RCAF, the Royal Ceylon Air Force and the South African Air Force.

Beaufort (Air-Sea) Equipment Ltd., Birkenhead: Pressure suits and breathing apparatus, dinghies for civil and military applications, ranging from a single-seat dinghy to the type 26V inflatable life-raft.

G. & E. Bradley Ltd., London: Type VE 45 TACAN test equipment, developed under British Government contract to test the performance of TACAN airborne equipment; electronic research and production.

Bristol Aerojet Ltd., Banwell: Compact gas storage vessels of high energy/weight ratio for use in aircraft and guided missiles, approved for operation under ARB and military conditions; available in spherical, cylindrical, annular and toroid form. Solid fuel rocket motor cases. Plastics (Bristol Aeroplane Plastics Ltd.), including a reinforced plastic life-raft container, drop fuel tanks and a nose cone for the *Bloodhound*.

Bristol Siddeley Engines Ltd., Ball Spline Division and Ball Screw Division, Coventry: High efficiency ball screws for temperatures between −55 °C and +450 °C; ball splines.

British Oxygen Co. Ltd., London: Miniature expansion turbine with air-lubricated bearings; liquid oxygen breathing equipment for crews and passengers; oxygen ground handling, servicing, repair and storage equipment; regulators and valves for liquid oxygen equipment; liquid nitrogen fuel tank explosion suppression systems.

British Petroleum (BP), London: New fuelling equipment and procedures; fuel filtering processes based on work done by the Air BP Filtration Test Unit; lubricants for aviation.

Cellon Ltd., Kingston-on-Thames: Aircraft dopes and finishes conforming to DGI and ARB requirements.

Champion Spark Plug Co., London: Spark plugs and jet engine igniters for all performance classes.

CIBA (ARL) Ltd., Duxford: *Redux* and *Hidux* bondings; *Aeroweb* honeycomb core; *Araldite* epoxy resins for the manufacture of press tools and glass laminated structures and the potting of electronic components, and an *Araldite* and glasscloth guided missile radome nose cone.

Cossor Radar & Electronics Ltd., Harlow: Indoor stand—a range of components including isolators and circulators for strip transmission lines. On an outdoor site a demonstration will be given of primary, secondary and meteorological radar, with particular emphasis on operational secondary surveillance systems. Cossor SSR 1251 transponders are standard equipment in e.g. BOAC's Boeing 707s. CRD.23 traffic control radar with aircraft identification device; CRD.787 airfield surface movement indicator.

The Decca Navigator Company Ltd., London: Decca/Dectra navigation systems; Decca Navigator Flight Log; Decca *Omnitrac* navigational computer, which uses a standardized map of the world to coordinate navigational data gathered from a wide variety of sources, giving a distortion-free pictorial presentation with automatic map-changing.

Decca Radar Ltd., London: Decca DASR-1 10-cm air surveillance radar for detecting targets up to 120+ nautical miles distance and 40,000 ft altitude; Decca WF-2 high altitude windfinding radar; HF 200 military heightfinding radar, operating in the S-band with hydraulic mechanisms. Decca long-range air defence radars.

De Havilland Propellers Ltd., Hatfield: In addition to development and production of missiles and propellers (the latter for 150 h.p. to 9,000 h.p., for piston engines and turboprops), this company also manufactures a wide range of accessories, including the ACORN (automatic checkout and recording equipment) for testing complete systems in aircraft, missiles and ground equipment; fully automatic electrical fuel control equipment for helicopters (for the *Gnome* engine); electronic flowmeter and test equipment.

Delaney Gallay Ltd., London: Pressed parts of Nimonic, stainless steel and light metal alloys; insulation blankets; oil coolers for

gas turbines; heat exchangers; hermetically sealed panels and ducting; wing de-icing systems and special heat insulating felts.

Dowty Group Ltd., Cheltenham: Undercarriage components, including main undercarriage legs for the Armstrong Whitworth *Argosy*, Avro 748 and Avro *Vulcan*; also fuel flowmeters and distributor systems.

Dunlop Rubber Co. Ltd., Coventry: Tyres, wheels and brakes, e.g. for the DH.121, VC.10 and SC.5. De-icing systems for Rolls-Royce *Dart* and *Tyne* turboprops. Dunlop de-icing systems are also used on the following aircraft: AW *Argosy*, Avro 748, Breguet *Alizé*, Bristol *Britannia*, Canadair CL-44, Fokker *Friendship*, Fairey *Gannet*, Handley Page *Herald*, Vickers *Vanguard*, etc.

Ekco Electronics Ltd., Southend-on-Sea: Fully transistorized dual-system lightweight weather radar type E190, with a range of up to 150 miles; weight 103 lb. The system employs two transmitter/receivers, two indicators, a scanner and junction box. Other exhibits include transistorized inverters for aircraft and ground use.

Elliott Brothers (London) Ltd., London: Will be represented by eleven divisions showing air data systems and flight control instruments (e.g. for VC.10), aircraft instruments and communications equipment. Also fire control radar, multi-channel equipment for data transmission, klystrons and magnetrons in the 35 Gc/s and 75 Gc/s band, diodes and fuel management systems.

English Electric Company Ltd., Aircraft Equipment Division, Bradford: Electrical equipment, including brushless alternators; constant speed power supplies for aircraft.

Ferranti Limited., Aircraft Equipment Dept., Manchester: Instrumentation system for helicopters (includes reference horizon, hovering and navigation instruments with relevant computers and data indicators).—Ferranti, Edinburgh: *Airpass II* dual purpose radar fire control and navigation system. Also fire control system for *Bloodhound* missiles, electronic computers and data handling systems.

Firestone Tyre & Rubber Co. Ltd., Brentford: Aircraft tyres of all kinds, in particular high speed tyres for modern jets; the 46 × 16 model as supplied for the main wheels of the Boeing 707. *Sky Champion* tyres with shock-proof nylon reinforcement.

Firth-Vickers Stainless Steels Ltd., Sheffield: Development and production of corrosion-resistant, heat-resistant steels (more than 90 percent of the materials used in the Bristol T.188 research aircraft come from Firth-Vickers).

Flight Refuelling Ltd., Blandford: Probe and drogue in-flight refuelling system; pressure fuelling systems from hydrants, and radio controlled targets for missile testing. Mark 20 refuelling pack for fighters; permits refuelling at 40,000 ft altitude and speeds up to 300 knots; rate of flow 150 gal./min.

P. Frankenstein & Sons (Manchester) Ltd., Manchester: Inflatable clamshell shelter for vehicles, small aircraft etc.; the skin of the shelter rests on a framework of high-pressure tubes. The latter have been developed by Walter Kidde Co. Ltd., though the structural design is by P. Frankenstein & Sons and Beaufort (Air-Sea) Equipment Ltd.

General Precision Systems Ltd., Aylesbury: Flight simulators and training equipment for the Air Forces of numerous countries, including flight simulators for the RAF's *Lightning* fighter and *Vulcan* bomber.

The Goodyear Tyre & Rubber Co. (Gt. Britain) Ltd., Wolverhampton: Tyres, wheels, brakes and anti-skid devices. Exhibits include Goodyear equipment (e.g. hydraulic brakes) as designed for the Blackburn NA.39 naval strike aircraft. Also *Bluedot* tyres and erosion-resistant covers for radomes.

Graviner Manufacturing Co. Ltd., London: Fire detecting equipment for aircraft use, smoke detectors, Firewire, thermostats and explosion warning equipment.

Heenan & Froude Ltd., Worcester: The Froude PT 20 dynamometer for propeller turbines (6,000 b.h.p. at up to 1,500 r.p.m.).

High Duty Alloys Ltd., Slough: Parts made of Hiduminium, steel, titanium, etc. In particular Hiduminium R.R.58 (an aluminium alloy for high temperature applications) and examples of the use of Hiduminium R.R.257.

H. M. Hobson Ltd., Wolverhampton: Hydromechanical constant speed alternator drive type 403 for alternators up to 22½ KVA; servo motors for the operation of leading-edge slats and landing flaps (e.g. for DH.121); also fuel pumps, fuel flowmeters, etc.

The Hymatic Engineering Co. Ltd., Redditch: Pneumatic equipment for aircraft and missiles, including valves for extreme operating conditions.

Imperial Chemical Industries Ltd., London: In particular titanium alloys as developed by ICI's Metals Division.

International Aeradio Ltd., London: Push-button operated punched tape equipment type IA 301 for relay stations in communications centres.

The Walter Kidde Co. Ltd., Northolt: Emergency oxygen systems for passengers and crew; ultra-lightweight portable oxygen breathing sets; lightweight portable fire extinguishers; inflatable radar reflectors.

Lodge Plugs Ltd., Rugby: Sparking plugs and igniters; "Sintox" ceramics and examples of their utilization.

Joseph Lucas (Gas Turbine Equipment) Ltd., London: A wide variety of accessories and equipment for use in hydraulic, fuel and lubricant systems.

Marconi's Wireless Telegraph Co. Ltd., Chelmsford: Exhibits on the stand jointly occupied with Amalgamated Wireless (Australasia) Ltd., Canadian Marconi Co. and Marconi Instruments Ltd. include fully transistorized airborne communications equipment and ADF equipment; also a so-called parametric amplifier for use with 50-cm radar equipment, giving a 25 percent range increase. SNW 51 storm warning radar for ranges up to 200 nautical miles; S244 height-finding radar which, in conjunction with the Marconi surveillance system, can locate fifteen targets per minute; S264A 50-cm surveillance radar; digital and analogue computers for civil and military use.

Martin-Baker Aircraft Co. Ltd., Higher Denham, Middlesex: Mark GQ5 fully automatic ejection seat as fitted in the Lockheed F-104G for the German, Dutch and Belgian Air Forces. This seat is capable of ejection from ground level and airspeeds from 80 knots upwards.

Monk Bridge Iron and Steel Co., Leeds, Branch of Daniel Doncaster and Sons Ltd.: Turbine and compressor blades precision forged on aerofoil, or with machining allowances or completely finished machined; turbine blades of heat and creep resisting steels and Nimonic alloys; compressor blades in aluminium bronze, high creep stainless steels and titanium alloys; precision forgings for nuclear, missile and other equipment.

Murphy Radio Limited, Electronics Division, Welwyn Garden City: MR 851 multi-channel radio telephone offering, in conjunction with a multiplex telephony system, up to 36 channels. The equipment can be supplied as terminal or repeater stations, or with separate transmitting or receiving portion; frequency band 80 to 470 Mc/s; transmitter output 60 or 15 watts. MR 347 mobile transponder for Rebecca-Eureka. Lead cables for the "Autoland" system.

Normalair Limited, Yeovil: Aircraft air-conditioning, pressurization and oxygen equipment; research and development in breathing equipment for extreme altitudes.

Plannair Limited, Leatherhead: Cabin air recirculation blower (e.g. for Vickers VC. 10); the Type 9PL241-274 has a rate of flow of 1,280 cu.ft./min. at 7,900 r.p.m. and for a 15¼ inch air duct. Boost blowers for cabin ventilation, e.g. Model 6PL161-248 which runs at a speed of 6,000 r.p.m. with an output of 550 cu.ft. per minute with 3-inch ducts. Finally blowers for galley ventilation, radio rack cooling, etc.

The Plessey Company Ltd., Ilford: Exhibits include the series PV14 aerial multi-coupler system for use in the HF band for military and civil communications centres (frequency range 2 to 30 Mc/s); also PV95A VHF aerial amplifier which can feed six receivers simultaneously via a single aerial (frequency range 100 to 156 Mc/s). Also UHF equipment for ground-to-air and air-to-air use.

Pye Telecommunications Ltd., Cambridge: HF and VHF equipment for point-to-point and ground-to-air communications; ILS installations, such as are in service at airports throughout the world, and with the Royal Air Force, Ministry of Aviation, the Indian Air Force, etc. Also VHF equipment for long ranges and other transmitters and receivers, some of them fully transistorized.

Rotax Limited, London: Complete airborne electrical equipment; starters and ignition systems for aircraft engines; generators; transformers; rectifiers, etc. Test beds for d.c. and a.c. generators.

Rotol Limited, Gloucester: Propellers for the most varied applications, e.g. for Fairey *Rotodyne*, Fokker F.27 *Friendship*, AW *Argosy*, etc.

Sciaky Electric Welding Machines Ltd., Slough: Electrical welding machines, in particular new developments in the field of resistance welding machines.

S. G. Brown Ltd., Watford: Precision aircraft instruments, including Gyrotwin and Helicompass; also gyroscopes of all kinds, servo motors, potentiometers.

Smiths Aviation Division, jointly with K.L.G. Sparking Plugs Ltd., Waymouth Gauges & Instruments Ltd. and Kelvin Hughes Ltd., London: Control equipment and flight instruments, Smiths autopilot. Also ignition systems, fuel gauges and engine instruments.

Solartron Electronic Group Ltd., Thames Ditton: Digital data evaluation equipment; oscilloscopes; simulators.

Sperry Gyroscope Company Ltd., Brentford: A mockup of the stern of the first British missile-carrying destroyer "Devonshire" with *Seaslug* launchers and missiles will be shown on a joint stand with Armstrong Whitworth and GEC. Other exhibits will include the equipment for pre-launch checks of the *Seaslug*.

Standard Telephones and Cables Ltd., London: STR40 radio altimeter, a highly accurate frequency-modulated equipment designed specially for use in automatic landing systems; accuracy 3 ft or 3 percent of measured altitude; accurate to within 1 ft at touch-down. STC radio altimeters form an integral part of the aircraft equipment for fully automatic blind landings. Also STAN 7-8 instrument landing system as chosen e.g. for London Airport. SLA 3B2 precision approach radar, a mobile version of which (the SLA 3B1) is in production for the RAF. Finally other radio and navigation systems for aircraft and ground use; telephony and telegraphy equipment; telephony and radio telephony accessories; transformers; communications cables.

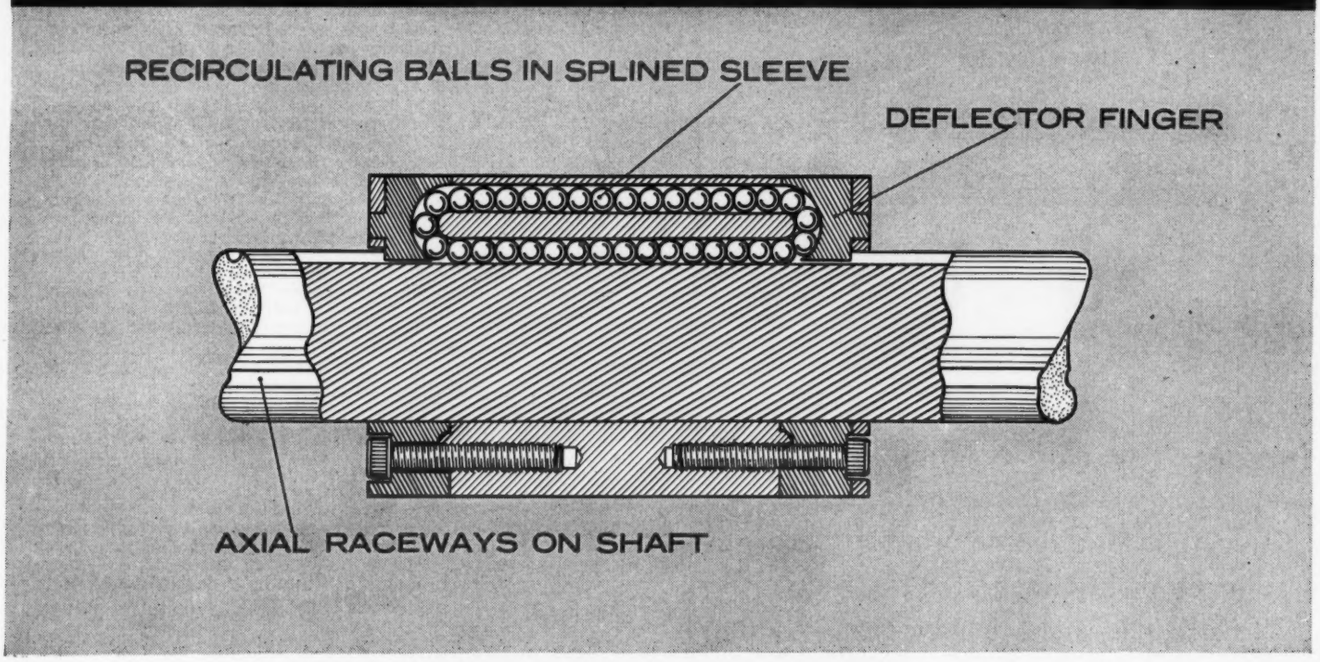
T.K.S. (Aircraft De-Icing) Ltd., London: Fluid de-icing system using Porosint Rigimesh porous stainless steel panel, for wing and tailplane leading edges.

Ultra Electronics Ltd., London: Development and production of radio and radar systems; servo controls with magnetic amplifiers; type UA60 intercom system; submarine detection equipment. The Continental Connector Division produces miniaturized precision multiple connectors.

Venner Limited, New Malden: Lightweight aircraft batteries (silver-zinc and silver-cadmium) exhibited by Venner Accumulators Ltd. Electronic equipment, in particular for test purposes, shown by Venner Electronics Ltd. Finally emergency lighting units.

Photo credits: p. 1057: Interavia files; pp. 1058-1064: manufacturers (2), Interavia (14); pp. 1065-1079: BEA (1), manufacturers (29), Interavia drawing (1); pp. 1080-1081: manufacturers; pp. 1082-1084: SAS (4), Interavia files (5), Interavia map (1); p. 1106: UAL: p. 1109: manufacturers; pp. 1117-1121: manufacturers; pp. 1122-1124: Herbert Wiesemann, Düsseldorf (1), Israeli Government Press Office (1), RAAF (1), manufacturers (10); pp. 1141-1142: manufacturers (5), Interavia drawing (1); p. 1143: manufacturers; pp. 1144-1146: author; pp. 1147-1148; manufacturers; pp. 1156-1158: manufacturers; p. 1159: manufacturers.

Ball splines, over 90% efficient, operate at -55°C to 450°C and over...



...ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce ball splines.* These ball splines achieve a minimum efficiency of 90% and they can operate within a temperature range of —55° C to over 450° C.

Machined and ground to the highest standards of precision, Bristol Siddeley ball splines are much more efficient in operation than conventional splines. They substitute a recirculating stream of precision-ground balls, rolling along specially contoured grooves, for the solid key and keyway. This arrangement reduces friction to a minimum when the spline assembly is subjected to linear, torque and bending loads. It also gives optimum smoothness and a very fine degree of positioning accuracy. When compared to conventional spline mechanisms, Bristol Siddeley ball splines require a much smaller power source; provide a predictable operating life; need much less maintenance; and give long, trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification and each unit is specially designed for its particular application. For the splines can be made with angular pre-loading, with multiple circuits, and with telescopic extensions. Bristol Siddeley splines have been proved as the most efficient method of minimising friction when high torsional and bending loads are imposed during linear movement in many engineering applications. They have been designed already with rated operating torque capacities of 50,000 lb/in (200,000 lb/in maximum static torque) but the maximum potential operating torque is, in most cases, limited only by the requirement.

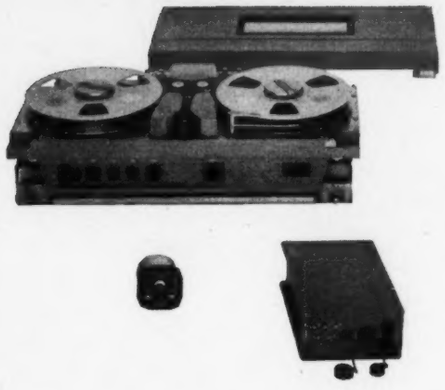
Bristol Siddeley ball screws

reduce the power required for actuation by as much as 80%. By eliminating backlash. with pre-loading, they give precise control over very small increments of motion when converting rotary drive into linear output.

**Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to: J. B. Starky, Sales Manager (Ball Spline Division), Bristol Siddeley Engines Limited, PO Box 17, Coventry, England.

BRISTOL SIDDELEY ENGINES LIMITED



The AMPEX AR-200

is an analogue magnetic tape recorder for airborne or mobile use. A completely integrated system, it occupies just 1.6 cubic feet of space and weighs only 95 pounds. The AR-200 performs reliably from −54° C. to +71° C., at altitudes to 100,000 feet, and will withstand 15g shocks and 10g vibration. Electronics are all solid state, and the recorder operates on 28 volts DC. Converters are available for use with other power sources. Standard speeds are 1⅞, 3¾, 7½, 15, 30 and 60 inches per second. The AR-200 can be used for direct, FM-carrier, PDM or digital recording. Models are available for up to 14 analogue tracks or 16 digital tracks. I. R. I. G. compatible at no extra cost. For specifications write to Ampex Great Britain Limited, Arkwright Road, Reading, Berks., England. AMPEX

Interavia Air Letter Reports...

(Continued from page 1005)

New aircraft, new engines

A new twin-engine Cessna touring aircraft for at least four persons is shortly to come onto the market. A prototype is now under construction, though no designation has yet been announced. First flight is planned for early 1961.

●

The Hawker Siddeley Group and William Denny & Bros. Ltd., shipbuilders and marine engineers of Dumbarton, are to enter the field of hovercraft design and development. The two companies will each collaborate with Hovercraft Development Ltd., the subsidiary company set up by the National Research Development Corporation to promote hovercraft development in the U.K. No details have yet been announced concerning the type of craft projected by Hawker Siddeley, though it is reported that the actual work will be carried out by Folland Aircraft Ltd. William Denny & Bros. will concentrate on river craft. In addition to Hawker Siddeley (Folland) and William Denny, other companies in the U.K. interested in hovercraft work include Westland Aircraft (Saunders-Roe Division) and Vickers Armstrongs (South Marston). The two latter companies are also in close contact with Hovercraft Development Ltd.

●

The latest version of the Rolls-Royce Avon bears the designation RA.24R ; thrust 14,430 lb. In all probability this engine will be fitted in the English Electric *Lightning* and in later versions of the Saab *Draken*.

●

BSRJ.824 is the designation of a new ramjet engine designed by Bristol Siddeley. It is already making test runs at the company's high altitude test plant. Diameter 18 in. ; length 99.6 in.

●

Royal Netherlands Aircraft Factories Fokker is examining plans for a new version of the *Friendship* with fuselage stretched by 6.9 ft and cabin accommodation for 48 instead of 40 passengers. One company reported to be interested in this model is Eastern Air Lines. The new *Friendship* would have double slotted flaps and be powered by Rolls-Royce *Dart RDa.7* or *R.Da.10* powerplants.

●

N. I. Kamov is bringing out a four-seat advanced model of his Ka-18 helicopter, to be known as *Malyutka*. It will have two coaxial three-blade rotors and a 280 h.p. engine designed by A. Ivchenko. The *Malyutka* can be operated over distances of up to 160 nautical miles at a cruising speed of roughly 80 knots.

First flights, testing and type certifications

The Max Holste MH.260 Super Broussard, a feeder airliner for 20 to 23 passengers equipped with two Turboméca *Bastan* turboprops of approx. 1,000 h.p. each, began flight testing at Reims-Courcy airfield on July 29th, 1960.

●

The prototype of the Armstrong Whitworth AW. 660 transport for the RAF also made its first test flight on July 28th, at the Bitteswell airfield. The AW. 660 has a so-called "beaver tail" for rapid loading and unloading and can carry a payload of some 14 tons. It will be recalled that the first production model of the AW. 660 is expected to be ready for flight testing in December 1960, and that this transport is to go into service with RAF Transport Command in 1962. Up to the present time, forty AW. 660s have been ordered for the RAF.

●

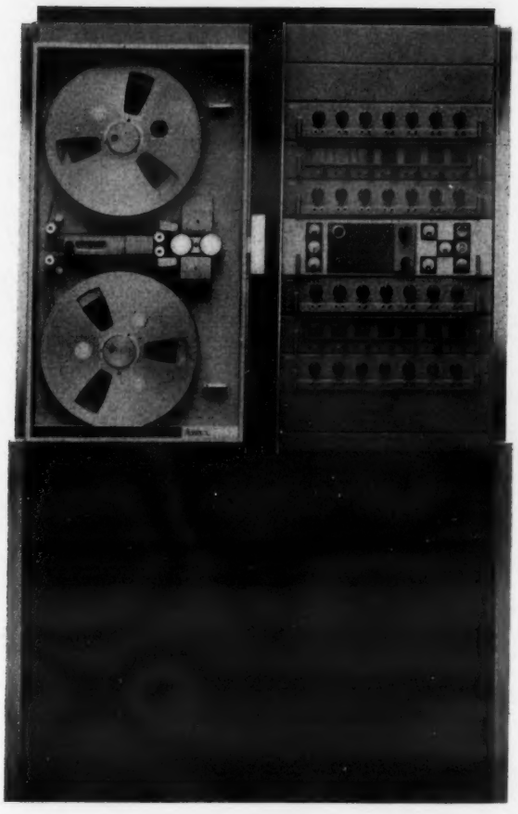
The Cessna CH-1C four-seat helicopter has been awarded FAA certification for flight under IFR conditions—the first American helicopter to achieve this award.

●

The Pratt & Whitney JT3D turbofan engine (17,000 lb thrust) has also received its FAA certificate. Engines of this model are fitted, for example, in the Boeing 707-120B and 720B and certain versions of the Douglas DC-8.

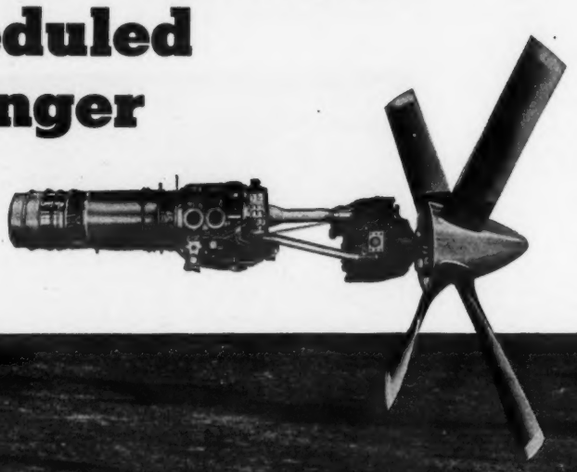
★

VDS (Variable Depth Sonar) will in future be standard equipment on all NATO submarine units, according to reports from British naval circles. VDS was jointly developed by Canada, the USA and Great Britain and represents a marked advance over the ASDIC system first used in World War II. Whereas ASDIC (named after the Allied Submarine Detection Investigation Committee) had to be towed behind anti-submarine vessels at a constant depth, VDS, as the name implies, can operate at variable depths. Though no details of the system are yet available, its effective range is said to be considerable.



The AMPEX FR-600 is an advanced-design data recorder with twice the capacity of conventional recorders. Most analogue recorders can only record 24 minutes of 100 Kc data on a 14-inch reel of 1 mil tape. The FR-600 will record 48 minutes of the same data on the same reel of tape. The reason – greater bandwidth at a given speed . . . 125 Kc at 30 ips, for example. Many data-runs are 30 minutes or longer, requiring a stand-by recorder to pick up where the first leaves off . . . an expensive price for a few extra minutes of recording time. The FR-600 literally does the work of two conventional machines by enabling double record time for any given bandwidth, or double bandwidth for any given record time . . . 250 Kc at 60 ips, for example. Another cost-saving feature is the tape shuttle which automatically scans any portion of the tape, eliminating the need for a separate loop recorder. Modular plug-in, solid-state electronics warm up in less than 10 minutes, and FM amplifier drift is less than one percent in 24 hours. Other advanced features of the FR-600 include pneumatic tape guiding, tension sensing and control, adjustable search speed and fourteen miniature monitor oscilloscopes. For complete information write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

Allison Prop-Jet Convairs to begin scheduled airline passenger service



Allison 501 Prop-Jet engines develop 3750 h.p. and are approved by the FAA to fly 1000 hours before overhaul.

Soon the first U. S. scheduled airline will put Allison-powered prop-jet Convairs into service. This prop-jet aircraft is ideally suited for the routes of this local service carrier, Lake Central Airlines, where flight segments average just over one-hundred miles.

Standard Convair 340/440 aircraft, converted to Allison 501 prop-jet engines and Aeroproducts Turbo-Propellers, cruise at 350 miles per hour—the fastest twin-engine jetliner now in scheduled local service. The Prop-Jet Convair climbs to 20,000 feet from sea level in just thirteen minutes. Its short field performance is exceptional. Full payload range is 675 statute miles—a profitable 550 miles greater than piston-powered Convair 340s.

The Allison Prop-Jet Convairs, now fully certificated by the U. S. Federal Aviation Agency, offer airlines and corporate operators jet-age advantages at lowest initial cost—and even on the shortest flight segments. Route analysis of several airlines reveal this jet-age plane yields 19% to 48% return on invested capital.

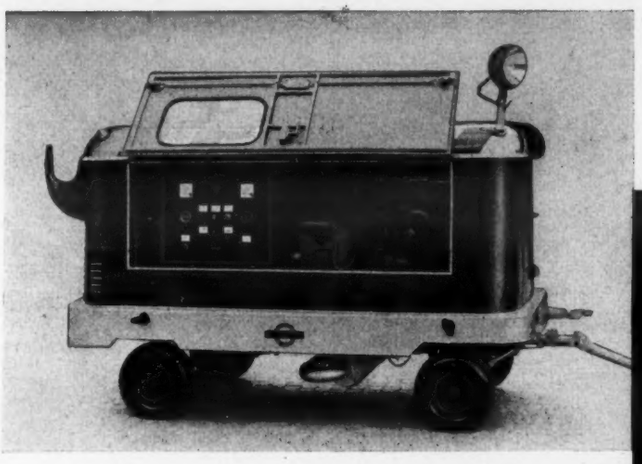
Lake Central's purchase of five Allison Prop-Jet Convairs, with options on ten more, increase to 16 the number of firm orders for this speedy economical aircraft. This includes the following corporate operators who desire for their executives the same advantages of modern jet age, economical transportation: AC SPARK PLUG DIVISION OF GENERAL MOTORS • ALLISON DIVISION OF GENERAL MOTORS • FORD MOTOR COMPANY • HUMBLE OIL COMPANY • UNION OIL COMPANY.

ALLISON PROP-JET POWER

. . . utilizing the worldwide recources of General Motors

GM JET POWER

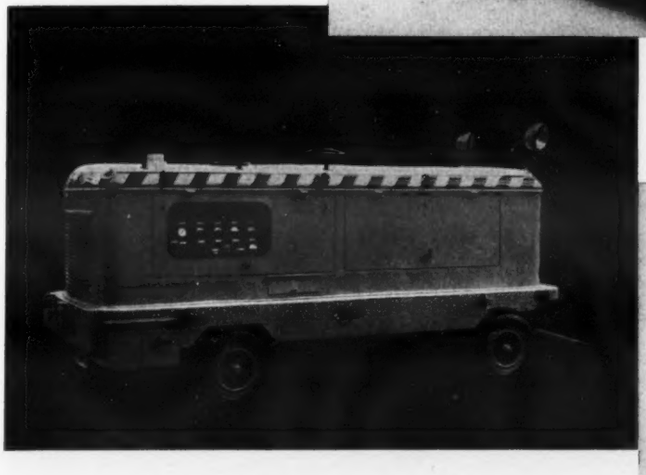
STRÜVER GROUND POWER SUPPLY SYSTEMS FOR AIRLINERS



JET-ELECTRIC 75 ▶
Self-propelled, diesel-powered equipment for supplying power to the BOEING 707, DC-8 and LOCKHEED ELECTRA requiring 400 c/s three-phase, 120/208 V.

◀ **ROLSTARTER** This equipment is used at many airports in Germany and other countries to start piston-engine aircraft and the VISCOUNT.

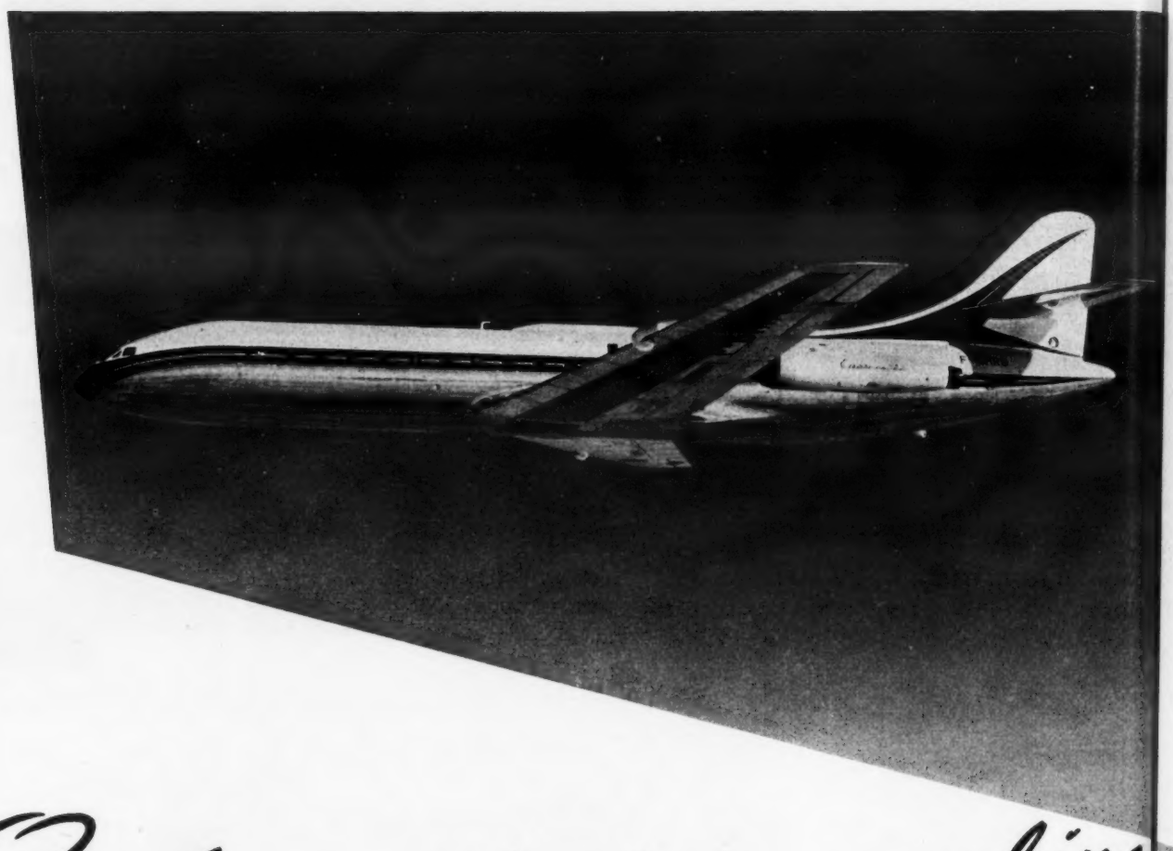
◀ **JET-FREQUENTA**
75 kVA frequency transformer for supplying jet aircraft with 400 c/s three-phase, 120/208 V, from a permanently installed underground cable system of normal voltage.



DUO-VOLTA ▶
Diesel dual-voltage unit with separate d.c. generators for 112 and 28 V, for starting and supplying power to the CARAVELLE and COMET jets, as well as the BRITANNIA and VANGUARD turboprops.

◀ **JET-AIRSTARTER** Diesel compressor unit for compressed air starting of BOEING 707, DC-8 and LOCKHEED ELECTRA aircraft.

AD. STRÜVER KG AGGREGATEBAU HAMBURG



Only a "jet" can combine

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JETS = SPEED

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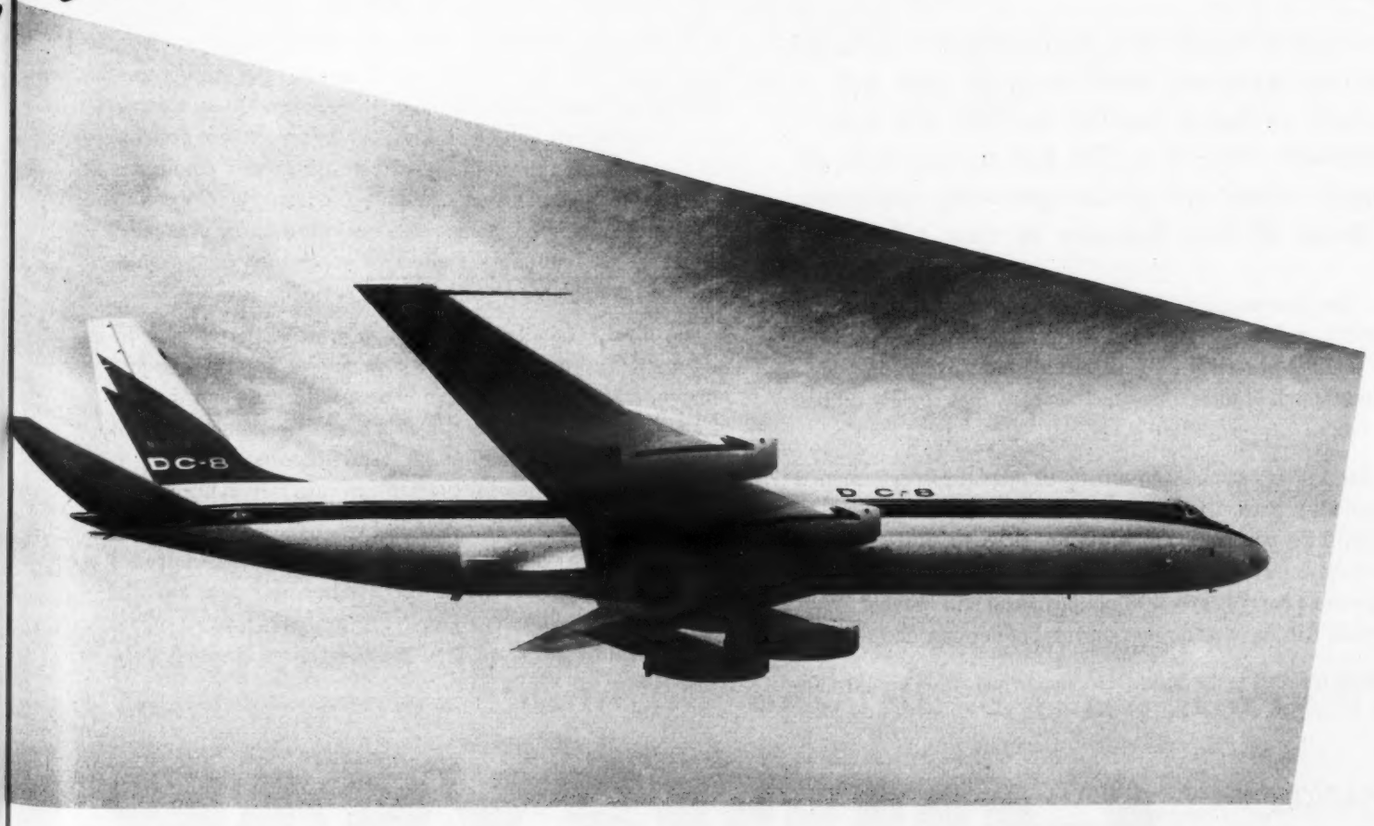
More flexible timetables	Less cash tied up in goods in transit
Quicker turnaround time	Reduced warehousing charges
	Packing problems simplified

economy with speed



500 kph "runway" is takeoff point for tires of future. Electronic programmer cycles tests via taped instructions.

WORLD'S FASTEST "RUNWAY"

rolls tire-testing ten years ahead in 18 seconds!

Goodyear's costly new dynamometer system qualifies aviation tires at over 500 kph—advances research frontier beyond 800 kph—accelerates from 0 to 500 kph in less than 20 seconds—simulates all tire operating conditions ...meets all test demands in view till 1970!

Next time you watch a 20-ton Mach 2 military jet taking off a runway at over 400 kph—or a huge 150-ton jetliner gracefully landing at nearly 240—recall this fact: everything rides on the stamina of their tires—and basically they're only rubber and fabric!

The Jet Age has established terrific standards of performance for aviation tires. Landing speeds of 500 kph are close to reality. Tire pressures are hovering close to 300 psi. Airplanes have put on weight at a rapid rate—today each pound of tire must carry nearly 400 pounds! And still tougher specifications will have to be met during the coming decade.

Looking forward to the future, Goodyear has made another big investment in a completely equipped tire-testing laboratory—most advanced in the tire industry. It features the 10-foot test-wheel shown here. Driven by a pair of giant 4300-hp electric motors, this wheel and allied equipment now make it possible for the first time to *exactly duplicate all service conditions* encountered by aviation tires—taxiing, takeoff, landing—with precision never before achieved. Tires can even be preheated to 427°C. to simulate the effect of supersonic flight, while yaw and camber to 15° can also be provided.

As you might expect from the company which developed the **first tubeless tires** specified for commercial aircraft—the **first low-profile tires** to meet USAF high-speed specs—and the **first sidewall-inflation airplane tire,** this new dynamometer system is another major breakthrough. And it gears Goodyear to handle the tire requirements for any aircraft flying today, tomorrow or in the foreseeable future.

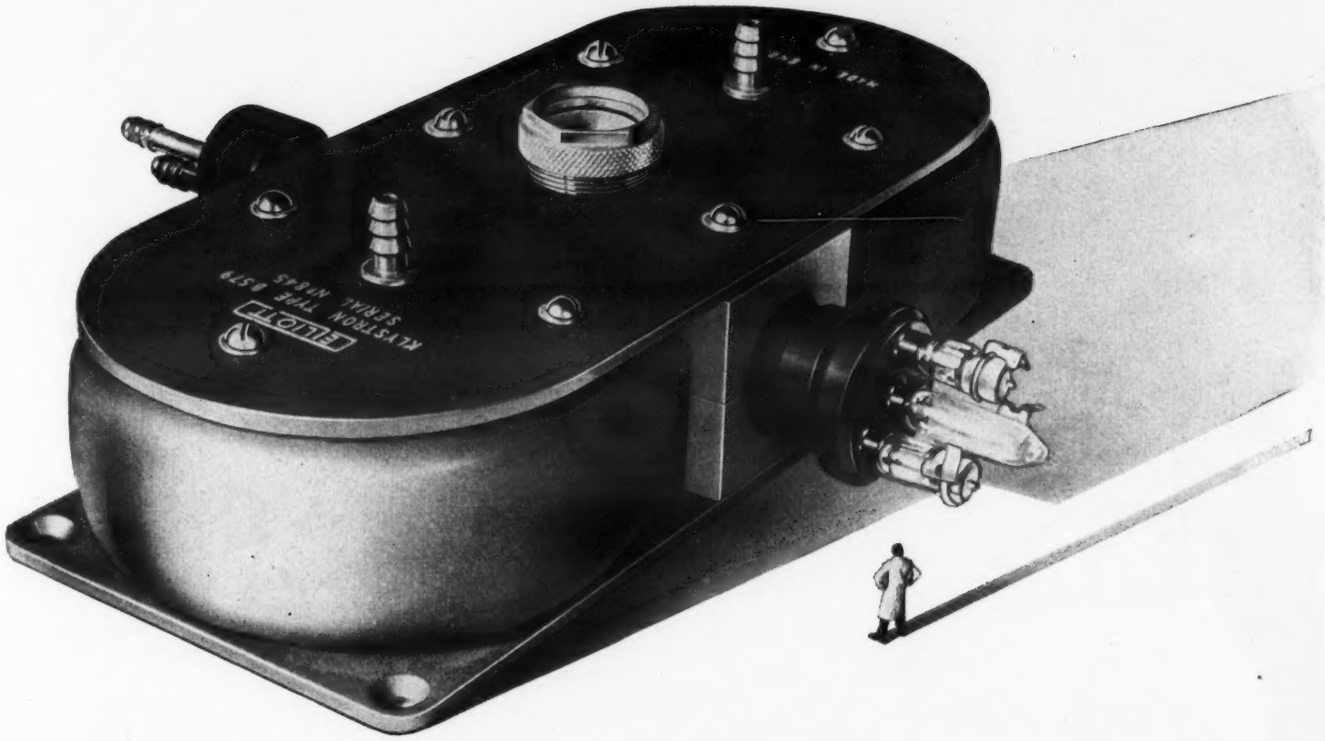
For information on this and other achievements in Goodyear's 50-year record of service to the aviation industry, and the more than 600 different Goodyear airplane tires, write to Goodyear International Corporation, Aviation Products Division, Akron 16, Ohio, U.S.A.

AVIATION PRODUCTS BY **GOODYEAR**

MORE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER MAKE

Where great things

are done with Microwaves



RADAR: Fire Control · Navigation of Aircraft and Small Ships · Automatic Landing · Missile Guidance · Transponders • **COMMUNICATIONS:** Multichannel Radio Links for telemetering Data and Speech • **VALVES:** Klystrons and Magnetrons for 35/GCS and 75/GCS bands · Monitor Diodes for I/GCS to 35/GCS • **INSTRUMENTS:** Comprehensive Waveguide measuring circuits covering 6 to 75/GCS • **RESEARCH:** Outstanding Research and Development of the latest techniques.

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Tires for "Jets" demand:

increased safety, *better* economy

Kléber-Colombes offers you laminated tires

These tires have a patented tread reinforced by superimposed layers of nylon cord fabrics incorporated in the rubber. This lamination increases the rigidity of the tread under compression and makes the structure more homogeneous. It resists premature destruction through internal heat build up and avoids the risk of the tread stripping off at high speeds. Moreover, the wear is more uniform and the endurance is increased.

Kléber-Colombes manufactures laminated tires

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...years ahead for years to come!

Solves your training problems

SATT Electronic Marking Target—an entirely new departure in the target field—gives maximum firing possibilities from aircraft, with automatic control. Several airplanes can fire at the same target in rapid succession and receive precise marking. No need for waiting in the air until the ground personnel has completed the marking job. This means saving fuel and a more effective use of the flying personnel's time for actual firing training.

A SATT target set-up consists of one or more electronically controlled sections (3×3 m = 10×10 feet). The picture above shows a 2-section target. The target is connected to the observer's stand where automatic counting televisors and memory units are located. Interference caused by radar, ricochets etc. is not registered.

SATT Electronic Marking Target gives you maximum firing training in minimum time.

For further information, call or write: BORGS FABRIKS AB, NORRKÖPING, SWEDEN.

- Rapid and exact individual marking.
- Gives more time for effective training.
- Saves fuel by saving time.
- Low interference sensitivity.
- Low power consumption (80 W from 12 V accumulator or 220 V 50 c/s).
- Can be set up in one or several sections.
- Scope of registration: All kinds of ammunition from 8 mm and up.
- Registration capacity: 200-1000 m/sec. (approx. 650-3300 feet/sec.)

Patent applied for.

Other products manufactured or represented

BEFAB Safeland Overrun Barriers and other airfield ground equipment.

BEFAB Safeland

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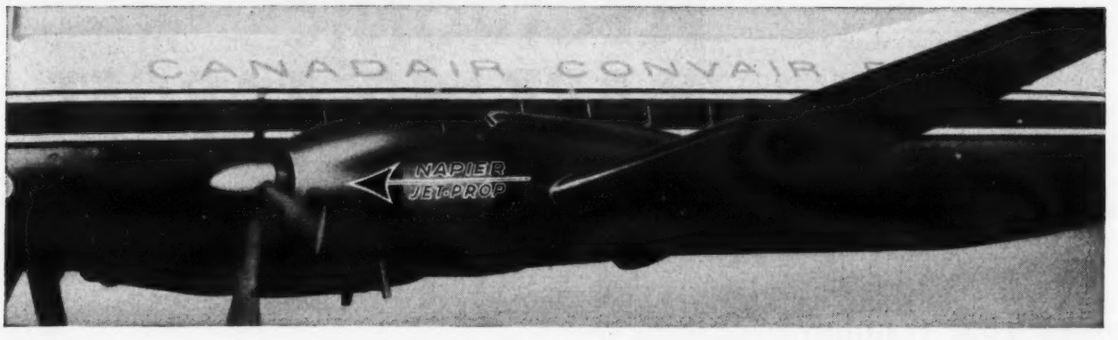
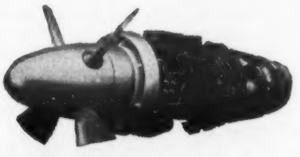
CANADAIR CONVAIR 540

LOOKS FORWARD 10 AIRLINE YEARS



WITH ELAND JET-PROPS

The Eland-engined Canadair 540, latest version of the world-famous Convair, offers airline operators an aircraft that will meet their requirements and growth for at least the next ten years. It ensures them a better payload, a faster block speed and lower operating cost, combined with high performance, strong passenger appeal and ease and economy of maintenance.



The Eland has high aerodynamic efficiency; low specific weight; low specific fuel consumption; single lever control; automatic temperature compensation.

NAPIER ELAND JET-PROPS

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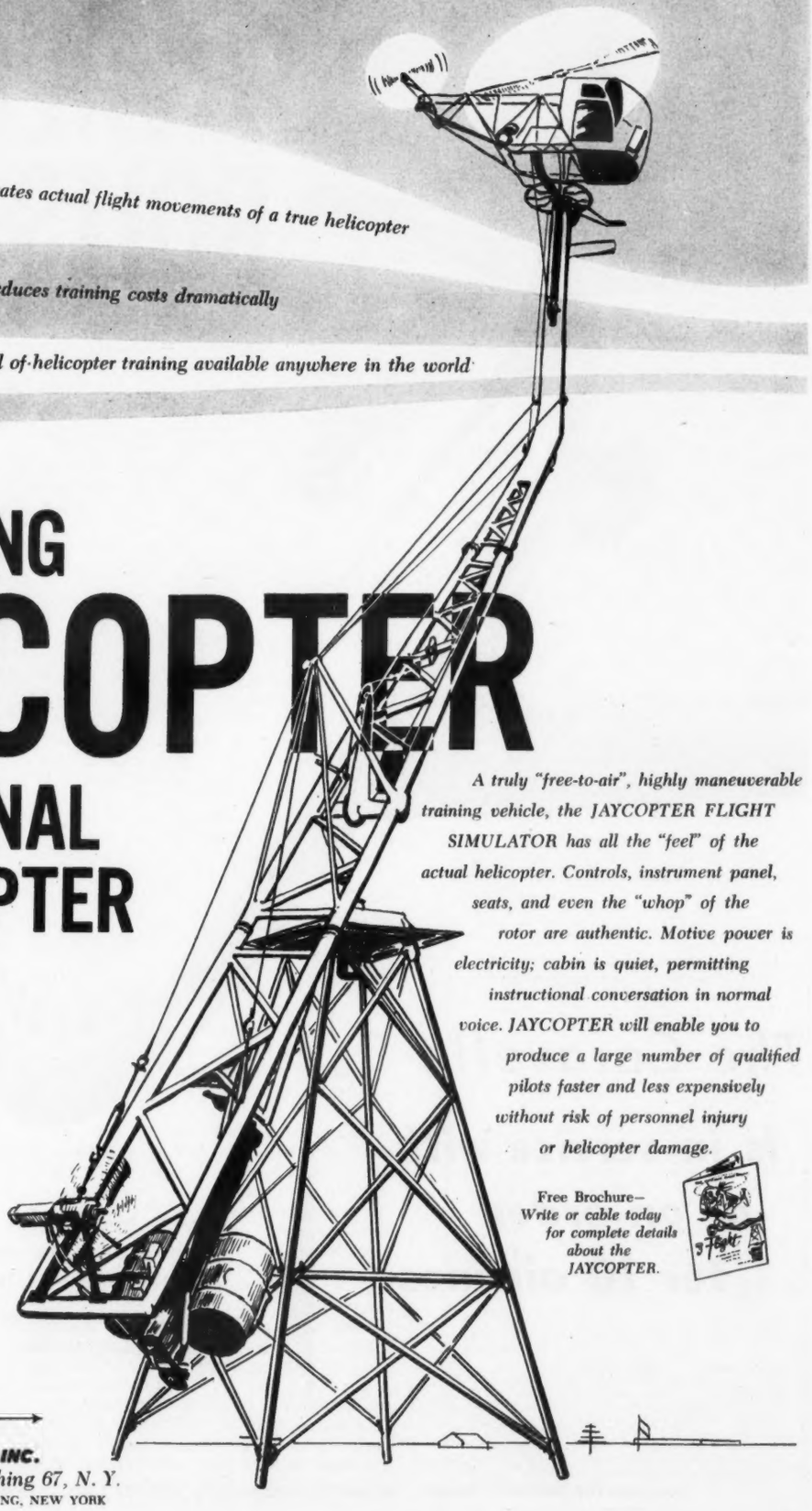
JAYCOPTER faithfully and realistically duplicates actual flight movements of a true helicopter

JAYCOPTER reduces training costs dramatically

JAYCOPTER is the safest, quickest method of helicopter training available anywhere in the world

PRESENTING THE JAYCOPTER SENSATIONAL HELICOPTER TRAINER



A truly "free-to-air", highly maneuverable training vehicle, the JAYCOPTER FLIGHT SIMULATOR has all the "feel" of the actual helicopter. Controls, instrument panel, seats, and even the "whop" of the rotor are authentic. Motive power is electricity; cabin is quiet, permitting instructional conversation in normal voice. JAYCOPTER will enable you to produce a large number of qualified pilots faster and less expensively without risk of personnel injury or helicopter damage.

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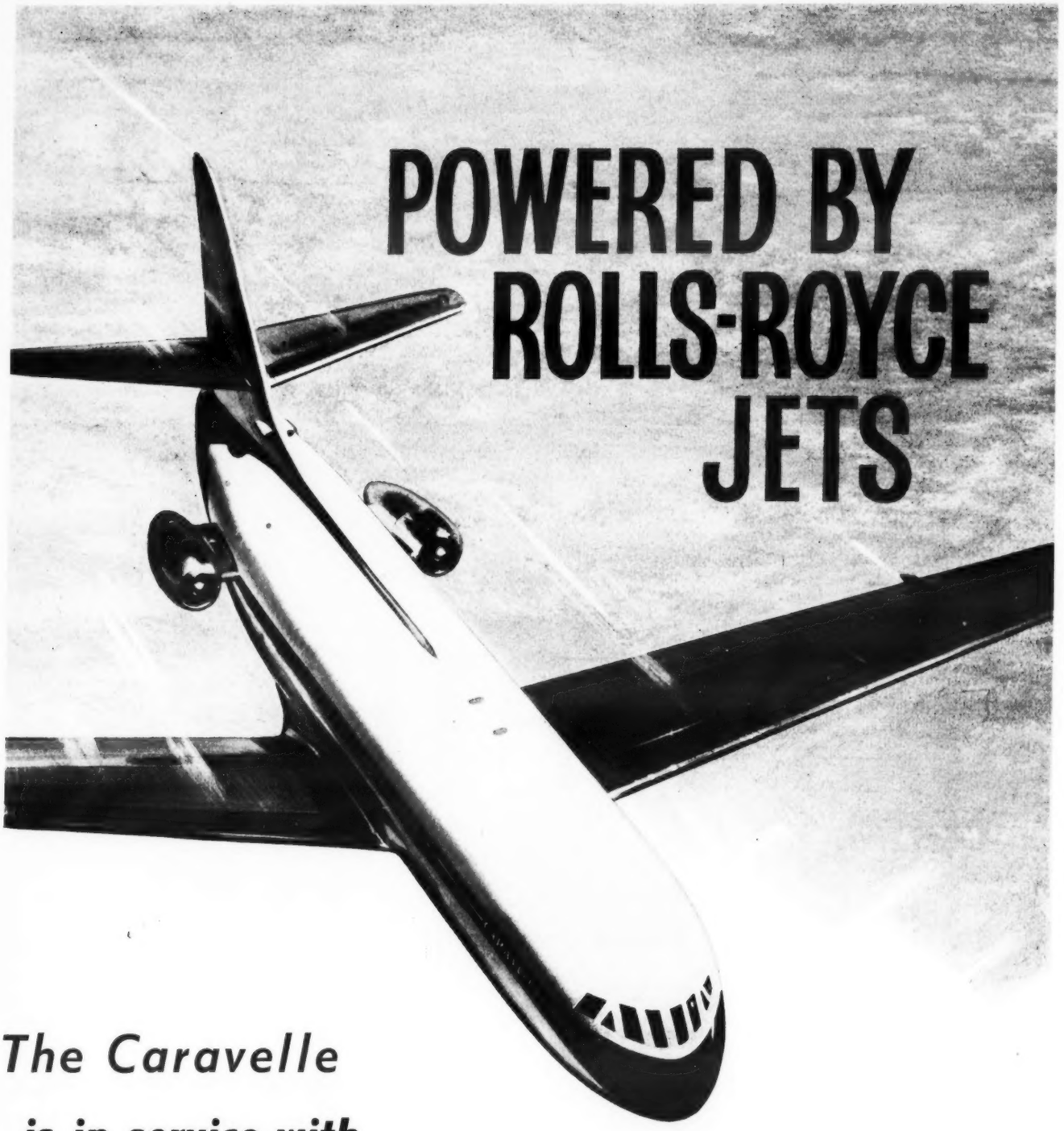

POWERED BY ROLLS-ROYCE JETS

The Caravelle

is in service with or on order for 10 airlines

Avon turbo-jets power all the 80 Sud Aviation Caravelles now in service with, or on order for, 10 airlines.

The RB.141 by-pass jet is available to power later Caravelles.

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Wall Street Watches the Missile Manufacturers

By Scott Hershey, New York

Wall Street is tracking, even as scientists track satellites, the business angles and the securities of contractors involved in the production of missiles in general and the *Polaris* in particular.

In an election year in the United States, of course, candidates from California to Massachusetts are promising almost any kind of defense weapons that any voter could ask for. At the same time, the candidates do not mention very loud, at least, about who is going to pick up the tab. Everybody is for defense spending. Somebody has to pay the bill.

The present temperament of the taxpayers and voters is that they want to know what they are getting for their money. The candidates propose to tell them between now and election day in November.

The Soviets are interested in the defense programs of the two political parties. So, too, are the people of the Free World. From both sides of the political fence assurances are that the United States is not going to do anything which will make the Soviets happy or make U.S. friends in the Western world unhappy if they can possibly avoid it.

There is a lot of missile-rattling going on in the world today—loud and striking from Mr. K. and an echo from Cuba, which despite its tinny sound, causes some concern. Just as a naughty child disturbs its elders who are trying to settle a neighborhood quarrel.

Some two billion dollars have been spent on the *Polaris* program since its inception about five years ago. There have been two principal contractors—Lockheed for the missile system and General Dynamics Electric Boat division for the nuclear submarine. Each of these prime contractors has let thousands of sub-contracts. The stocks of these companies are under Wall Street scrutiny as well as those of the prime contractors. And the *Polaris*, designed for submarine launching, can now be launched from land bases.

The Navy hopes, and its hopes have considerable backing, to get authorization for another $6.5 billion. This would give it 45 *Polaris* launching submarines and some 1,000 missiles. The total cost would be around $8 billion or more. It is figures like that which intrigue Wall Street, and while the money will come from the federal Government the financial fortunes of hundreds of corporations will be involved.

The money men see a period of growth for contractors involved in various phases of the defense program and indicate they are willing to aid in necessary expansion moves. Growth stocks have never been refused by the professionals, who look for profits and at the same time are aware of the risks involved.

At this point, two *Polaris*-launching submarines have been commissioned. One other has been launched, and six others are in various stages of construction. The Navy doesn't say which of its submarines are equipped with *Polaris* missiles.

The Navy has named the builders of five more *Polaris* submarines. Two will be made by Electric Boat at a total cost of more than $60 million, and one by Newport News Shipbuilding and Dry Dock for around $32 million. The figures do not include the atomic powerplants. The remaining two will be built at Navy shipyards throughout the nation.

With these new contracts, the *Polaris* fleet will include fourteen submarines. Of these, Electric Boat will have built six, including the "George Washington" and the "Patrick Henry," Newport News four and the Navy four.

Westinghouse has supplied the nuclear reactors for the first nine submarines. Neither Westinghouse nor the Navy has disclosed the cost of the reactors, but it is safe to say it is substantial—probably enough, according to some estimates, to bring the cost of each submarine to around $100,000,000.

Companies involved in contracts in this price range naturally appeal to investors. Each submarine is designed to carry sixteen missiles, and the cost of each missile is estimated at between $1,000,000 and $5,000,000. The wide gap here is because nobody really knows except the Defense Department and the various contractors involved, and most of them do not know the exact cost, either, since they handle only small segments of the whole.

It is understood that Lockheed has spent some $500,000,000 so far on research and development for the missile system, and another $1,000,000,000 has been spent on actual missile production. It is estimated that between $150,000,000 and $200,000,000 of Lockheed's 1959 volume was in *Polaris* missile contracts. Lockheed reports that about 400 major suppliers and many minor ones participate in its share of the program.

Major subcontractors include: General Electric for guidance and fire control; Westinghouse for the launcher and handling system; Aerojet-General Corp. for solid-propellant fuel and propulsion system and Interstate Electronics Corp. for instrumentation. Another important subcontractor is Sperry Rand Corp. which is responsible for the inertial navigation system which technically falls under the submarine part of the program.

Of the major *Polaris* companies, Lockheed stock was up on the New York Stock Exchange, as were the stocks of Newport News and General Dynamics. This market action has not been overlooked by the professionals in Wall Street. Gains also have been registered by some of the electronic companies.

Wall Street observers say that electronic, missile and other defense contractors can expect volume and profits to march upward, although individual companies will differ markedly from average results.

In connection with its contracts, the Navy reports it has 307 negotiated contracts valued at $6,618,719,000 that have not reached their target date for settlement or are awaiting final settlement. Of these 143 are of the incentive type with a value of $5,267,404,000, a four-to-one ratio to the value of the price-redetermination type.

The backlog of unsettled contracts is divided into two categories—those of contractor responsibility and those where the Navy accepts responsibility for delay. Contractors are blamed for failure to reprice sixty-one contracts valued at $1,685,448,000. The Navy states it is responsible for not settling 105 contracts with a value of $2,228,409,000.

A total of 172 contracts with a value of $3,914,257,000 are recorded as awaiting final settlement. This list includes those contracts on which negotiations have failed to reach a final price four months after the target date. Such contracts usually are referred to as delinquent.

In the list of delinquent contractors are Lockheed and Sperry with contracts valued between $50,000,000 and $100,000,000; Martin and McDonnell with values of $150,000,000. Unsettled contracts of Douglas are in the $200,000,000 range. Topping this list of delinquent contract values are Chance Vought and Grumman with $350,000,000 each.

The Navy responsibility list for repricing indicates that Philco, Western Electric and McDonnell are in the $50,000,000 to $100,000,000 contract value range. Companies in the $250,000,000 range are Douglas, Lockheed, North American, Chance Vought and Grumman.

The problem of reducing the backlog of unsettled negotiated contracts is a continuing one. Navy officials maintain that the negotiated contracts are the only way to get new modern weapons into production when neither the contractor nor the Pentagon can foresee exact costs.

Department of Defense Expenditures for Procurement and Production Total and Guided Missiles (millions of dollars) *

Year ending June 30th	Total Procurement and Production	Guided Missiles	Guided Missiles as Percent of Total
1951	$ 3,976	$ 21	0.5
1952	11,478	169	1.5
1953	17,123	295	1.7
1954	15,958	504	3.2
1955	12,997	718	5.5
1956	12,182	1,168	9.6
1957	13,649	2,095	15.3
1958	14,677	2,737	18.6
1959	14,410	3,494	24.2
1960 E	13,943	3,500	25.1
1961 E	13,602	3,479	25.6

* Table from "Aerospace Facts and Figures, 1960," published by the Aerospace Industries Association of America, Inc.

E = estimate; according to a report from Washington received at the end of July, the U.S. Congress fixed the limit of expenditure for the armed forces and the Department of Defense at $40,400 million dollars (USAF $17,200 million; Navy $12,200 million; Army $9,800 million; Department of Defense $1,200 million). Out of the USAF appropriations, $2,600 million are earmarked for guided missile procurement.

INTERNATIONAL MEETINGS AND CONFERENCES

Sept. 12th-16th: IATA 16th Annual General Meeting. Copenhagen.

Sept. 12th-16th: International Council of the Aeronautical Sciences, 2nd International Congress. Zurich.

Sept. 12th-17th: Ausschuss für Funkortung Conference on Marine Navigation and Safety. Kiel, Germany.

Sept. 18th-22nd: Fourth European Aviation Congress, organized by Wissenschaftliche Gesellschaft für Luftfahrt. Cologne.

Sept. 19th-22nd: Institute of Radio Engineers, National Symposium on Space Electronics and Telemetry. Washington, D.C.

Sept. 20th: IATA Composite and Joint Meeting of Traffic Conferences. Cannes.

Sept. 21st-25th: Air Force Association, National Convention and Aerospace Panorama. San Francisco, Calif.

Sept. 22nd-Oct. 2nd: 10th International Engineering Show. Turin.

Sept. 24th-25th: First International "Oktoberfest" Meet, organized by Munich Flying Club. Munich.

Sept. 25th-27th: Twenty-fourth Annual Convention, International Northwest Aviation Council. Harrison Hot Springs, British Columbia.

Sept. 26th-Oct. 1st: AGARD Structures and Materials Panel. Athens.

Sept. 27th-30th: American Rocket Society, Power Systems Conference. Santa Monica, Calif.

Oct. 3rd-4th: AGARD Flight Mechanics Panel: Manned Ballistics and Weapons Systems Testing. Istanbul.

Oct. 3rd-4th: AGARD Fluid Dynamics Panel: Industrial Uses of Wind Tunnels. Istanbul.

Oct. 3rd-5th: Institute of Radio Engineers, Professional Group on Nuclear Science. Seventh Annual Meeting. Gatlinburg, Tenn.

Oct. 3rd-5th: IAS Midwestern Meeting on Air Logistics. Tulsa, Okla.

Oct. 3rd-5th: First International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Association. San Francisco, Calif.

Oct. 3rd-8th: AGARD Aerospace Medical Panel: 1. Clinical problems in aviation medicine; 2. Space flight problems. Istanbul.

Oct. 3rd-8th: AGARD Avionics Panel: Navigation. Istanbul.

Oct. 4th-12th: Second Electronic Computer Exhibition. London.

Oct. 6th-7th: Tenth AGARD General Assembly. Istanbul.

Oct. 8th-9th: Genoa Air Rally. Genoa.

Oct. 10th-14th: SAE National Aeronautic Meeting. Los Angeles.

Oct. 17th-18th: Annual Joint Canadian Aeronautical Institute/Institute of the Aeronautical Sciences Meeting. Montreal.

Oct. 19th-26th: International Congress and Exhibition for Instrumentation and Automation (INTERKAMA). Düsseldorf.

Oct. 20th-21st: Canadian High Altitude Research Symposium, Canadian Aeronautical Institute Astronautics Section. Chateau Laurier, Ottawa.

Oct. 20th-21st: IAS and Denver Research Institute Symposium on Hypervelocity Techniques. Denver, Colo.

Oct. 25th-Nov. 21st: ICAO, Airworthiness Committee. Montreal.

Nov. 4th-5th: Institute of Radio Engineers, Symposium. Montreal.

The Mind of Mr. Reader

With one exception

Sir,

The coverage of vertical take-off aircraft in the May, Vol. XV, No. 5 issue of *Interavia* was excellent—with one exception... I must take objection to the captions and descriptive matter on page 559 of that issue.

First, it just isn't true that the development of the airplane was abandoned. The airplane fulfilled all contract specifications and, indeed, was so highly developed that it remains the only jet-powered VTOL airplane that has made at least 125 flights of hovering to transition and back to hovering.

Second, in the second paragraph on this page, you state that the difficulties of flying the tailsitters are extremely great. I know nothing of the difficulties encountered in flying the Coleopter/Flying Atar, but I do know that flying the Ryan X-13 Vertijet is, in the opinion of its test pilots, considerably less difficult than flying a helicopter. The aerodynamic and jet reaction controls are completely electronically integrated and controlled, offering the pilot a very full degree of ease and maneuverability.

Here is a copy of the Ryan Reporter, Vol. 19, No. 2 which, on page 24, contains an article by Pete Girard, who was the Chief Test Pilot on the X-13. In fact, Mr. Girard stated more than once that an average Service pilot can quickly be trained to fly the X-13.

San Diego, Calif. — James J. Mulvey, Ryan Aeronautical Company

As they have never had a personal opportunity of flying a tailsitter the Editors gratefully accept the assurance that the test pilots consider the Ryan X-13 was not difficult to fly. Having seen an impressive demonstration of this aircraft, they had rather gained the impression that certain special skills were required.

Swedish pilot supports Admiral Byrd

Sir,

Though not a specialist in either navigation, meteorology, or in polar flights, I must confess that as a pilot I have got the impression that Professor Liljequist has misused certain so-called facts in his analysis of the weather situation at the time of the flight.

He has, however, made a thorough evaluation of the most probable airspeed of the "Josephine Ford." He concludes that it should have been around 75 knots instead of the 89 knots published in "Jane's." I have no objection to this conclusion and I will use the even more conservative figure of 72 knots as an average for the northbound flight but will retain the 75 knots for the homebound leg, as the aircraft was then considerably lighter, and as there is a probability that an increase in power was considered possible after a calculation of the remaining fuel at the turning point.

Imagine now that you are going to plan the flight to the Pole with a plane making 72 knots and with the winds derived from the charts mentioned in Professor Liljequist's article. Let us assume that Amsterdamöya —the exit point—is passed at the cruising altitude, which eliminates the complication of calculating the climb. Winds from there to 88° N are given as very light southerly. As it is common in air navigation not to give direction for winds below 10 knots it is fair to assume the southerly wind being not less than 10 knots. The two charts available seem to differ on the wind direction in the immediate polar area (north of 88°N) so we propose the use of variable winds at 10 knots. In that case it is customary to reckon with a 10 knots headwind component for planning purposes, to be on the safe side.

The flight plan then turns out to be a very simple one:

	TAS knots	Wind o/kts	GS kts	D NM	t	T
79° 47'N - 88° N	72	S/10	82	493	6h02m	6h02m
88° 00' N - 90°N	72	var/10	62	120	1h56m	7h58m

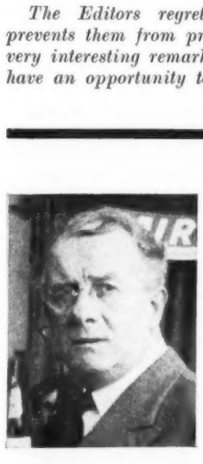
Average wind component + 5kts

The Byrd report states that the Pole was reached 7 h. 40 min. 30 sec. after passing Amsterdam Island, i.e. 17 min. 30 sec. ahead of flight plan, which means that the "Josephine Ford" should have had an average component of +10 knots. This is twice the forecast +5 knots and seems to confirm the statement that she never had a chance to reach the Pole under the existing conditions. That is for those who consider meteorology as an exact science, and it is on this point that I consider Professor Liljequist has used assumptions (or probabilities at the best) as bare facts.

As a practising pilot I cannot find anything abnormal in a discrepancy of 5 knots between forecast and actually encountered winds... My intention is only to show the limitation of a 33 year old weather map as the foundation for a theory that the "Josephine Ford" did not reach her goal. We need much stronger evidence to support the theory, before we can adopt it as probable.

Stockholm-Bromma — S. Boström

The Editors regret that lack of space prevents them from printing Pilot Boström's very interesting remarks in full, and hope to have an opportunity to return to them later.



J. H. Davis

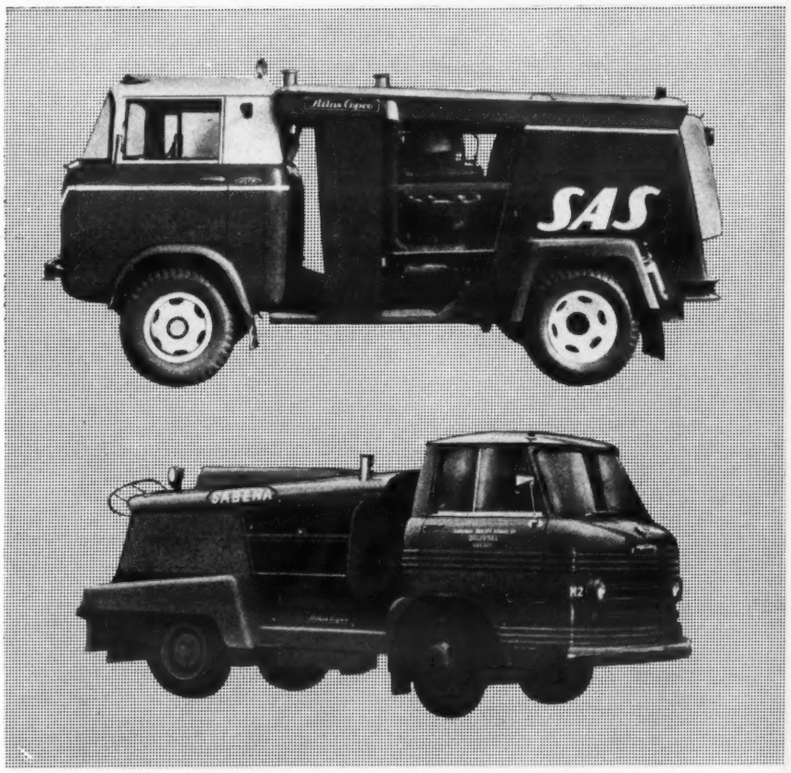
John Henry Davis, Canadair Ltd.'s European Representative in London, died suddenly on August 3rd, 1960, at the age of 61. Having served with the Royal Flying Corps during World War I, he moved to Paris after demobilization and later to Vienna, where he operated his own aircraft, a Hirtenberg HS.9. It was in this aircraft that he flew to England just before the outbreak of World War II. At the beginning of the war he joined the Bristol Aeroplane Company, and in April 1949 was appointed European Representative of Canadair Ltd., of Montreal. Mr. Davis was well known in international aircraft circles and was held in the highest esteem by all who knew and worked with him.

The trend is towards **AIR PARTNERSHIP**

More airlines (and airports) are adopting the Air Partner for Jet-liner starting

SAS KLM SABENA ALITALIA
TASMAN EMPIRE AIRLINES AIR-INDIA
CENTRAL AFRICAN AIRWAYS
SOUTH AFRICAN AIRWAYS
TRANS-CANADA AIRLINES . . .

These international airlines all use or have ordered the Atlas Copco Air Partner. Airports are also beginning to provide Air Partners as part of their ground service. Idlewild, Orly, Rome and Dusseldorf are among the first! A mobile starting unit which delivers *continuous power*, the Air Partner can be used on all jet and turbo-prop airliners with air turbine starters. A touch of the controls and it becomes an air-conditioning unit; fix a special mouthpiece to the air hose, and you have a de-icing machine. The Air Partner can be mounted on a trailer or any suitably-sized chassis—Ford, Volvo, Willys, etc.



MINIMUM MAINTENANCE

The Air Partner consists of an Atlas Copco TWIN-AIR rotary screw compressor — a design based on some ten years' testing and operating experience. Supplying a constant flow of warm, oil-free air — an essential condition for efficient starting — this compressor has few moving parts. Wear is thus practically eliminated and maintenance costs cut to a minimum — 10,000 hours is the normal period between overhauls for screw compressors of this type. Maintenance on the Air Partner can be carried out by airline personnel anywhere in the world or through the Atlas Copco sales and service organisation established in ninety countries.

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An Atlas Copco booklet giving full details of the Air Partner is readily available on request. Write for a copy to your local Atlas Copco company or agent or to the address below.

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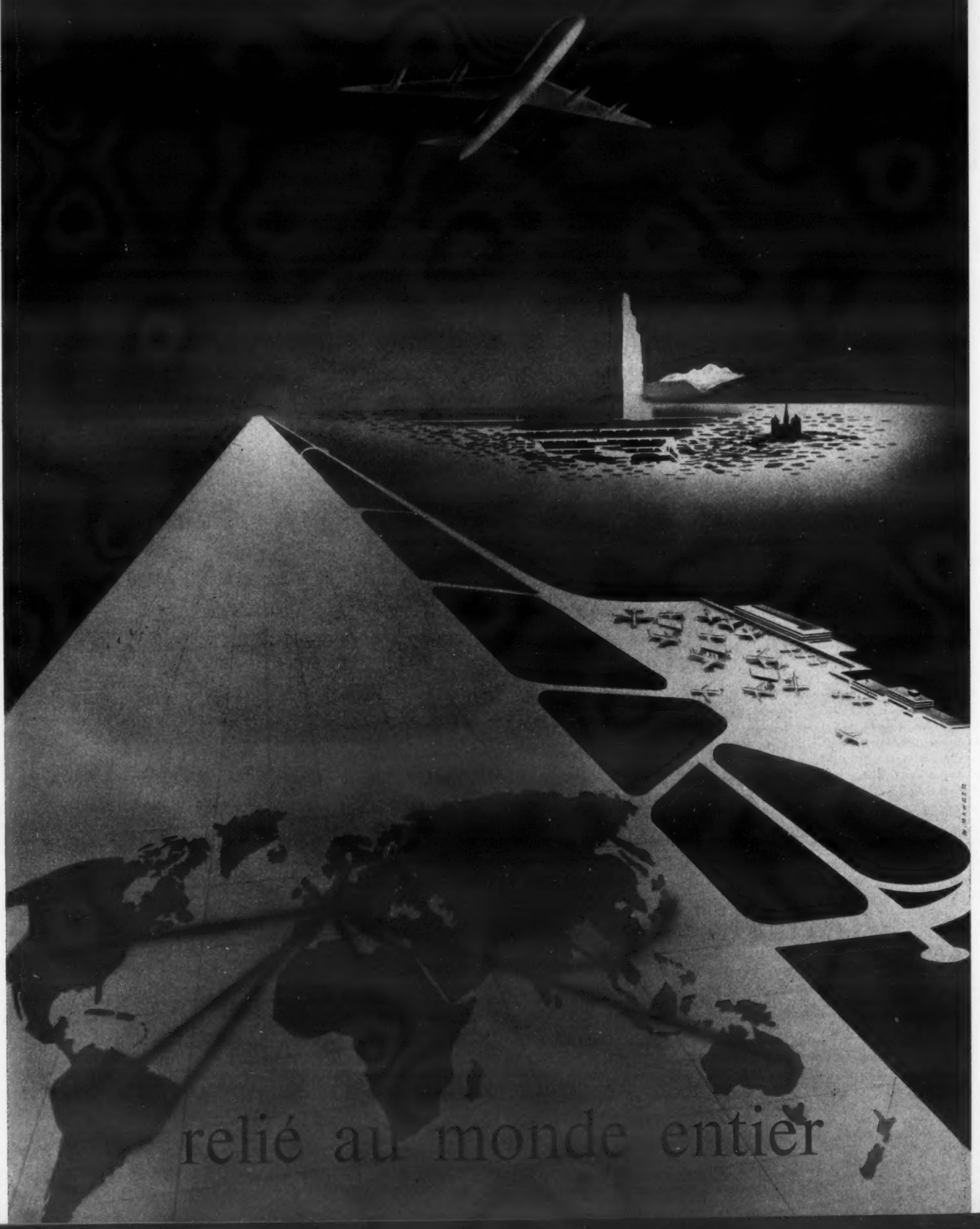
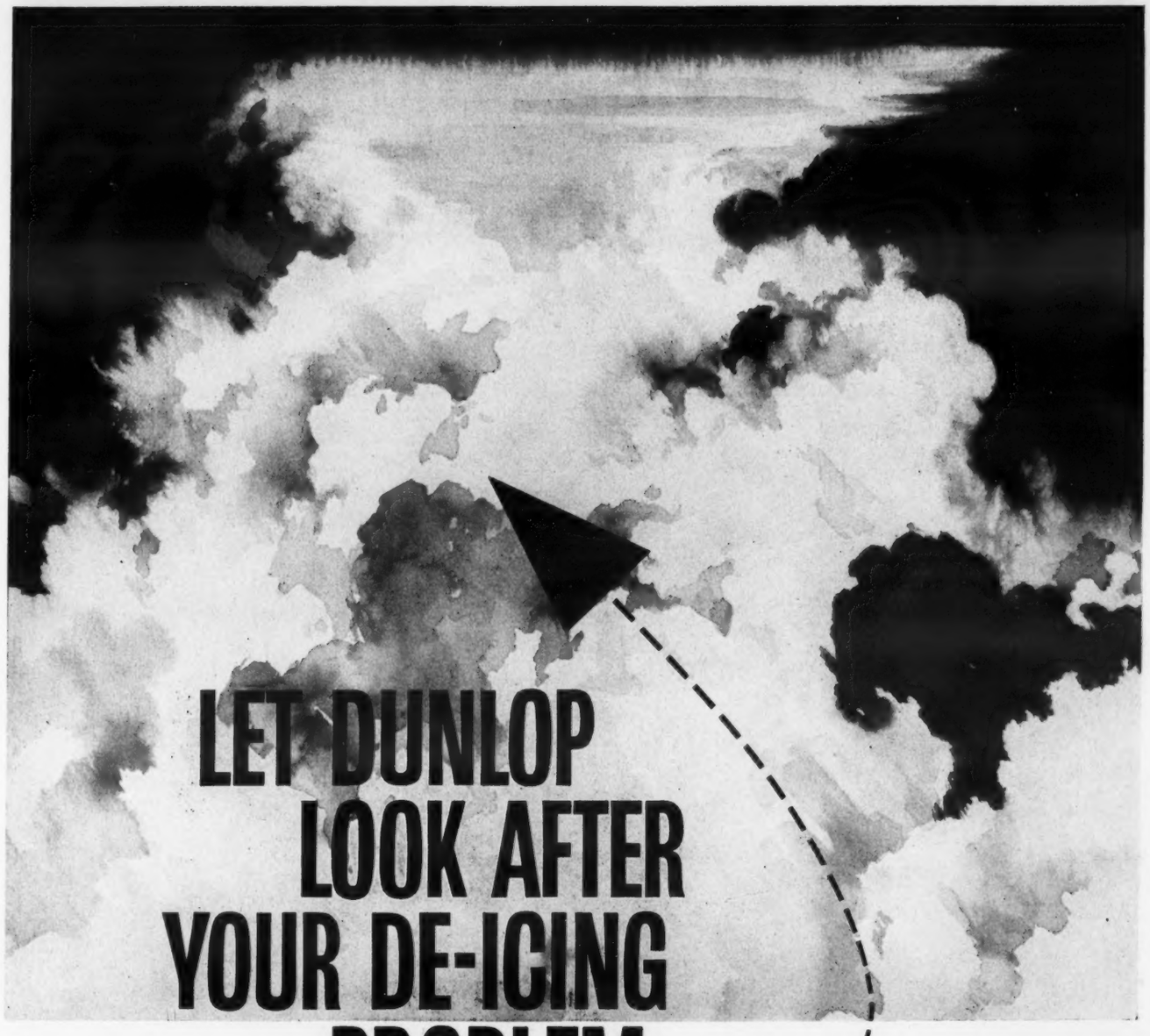


relié au monde entier



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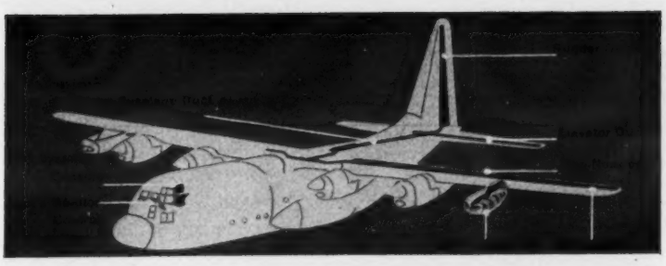
A boundary layer control system, which will spectacularly shorten the already astonishingly brief take-off and landing runs of Lockheed's versatile 61-ton C-130 Hercules transport, is now in an advanced stage of development and flight test.

The Lockheed BLC system culminates many years of study by Lockheed engineers and follows four years of research devoted to specific application of the system to the Hercules.

Four auxiliary jet engines, weighing only 500 pounds each, will furnish the streams of high pressure air which flow over all control surfaces. The BLC jet engines are each connected to a central system providing air evenly to all surfaces even with one engine out.

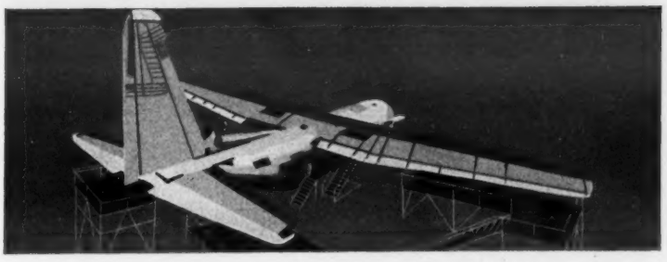
Manufacturing work on the BLC Hercules can begin now because 80% of the airplane is identical to the C-130 B. In Europe, a nation or group of nations could manufacture the C-130 B and have a European version flying in less than half the time required by a new untested design. The program could then be phased into the more advanced BLC Hercules. Know-how acquired by Lockheed in manufacturing nearly 300 C-130s to date can make the BLC Hercules European manufacturing project the most rapid and inexpensive answer to the needs of European nations for a high performance, all-purpose transport.

As a combat transport of men and equipment the C-130 showed its superlative value in airlifts to Lebanon and Turkey.



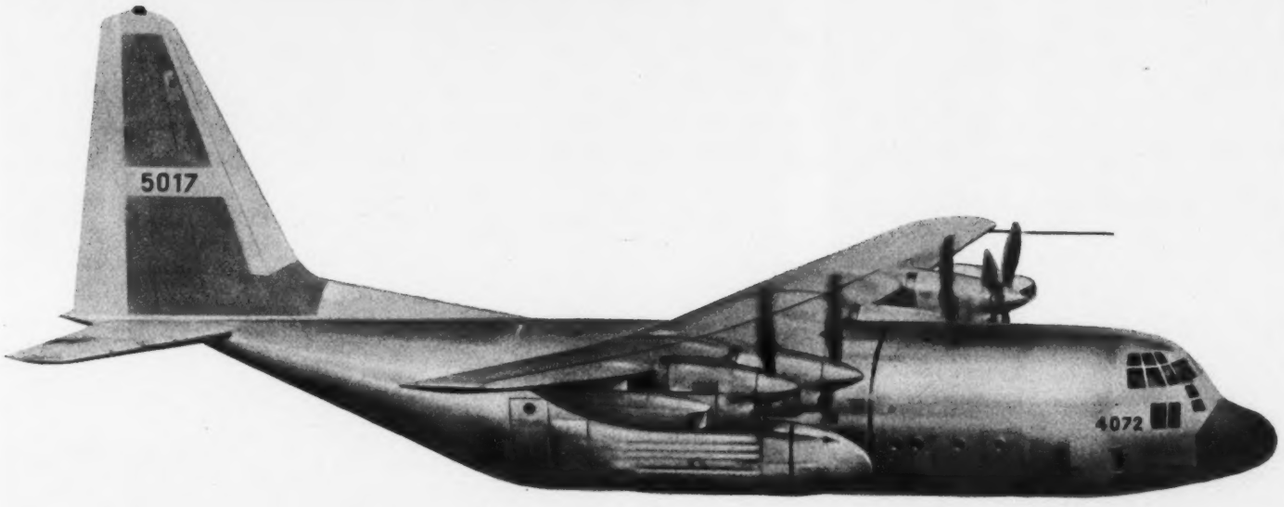
Boundary Layer Control

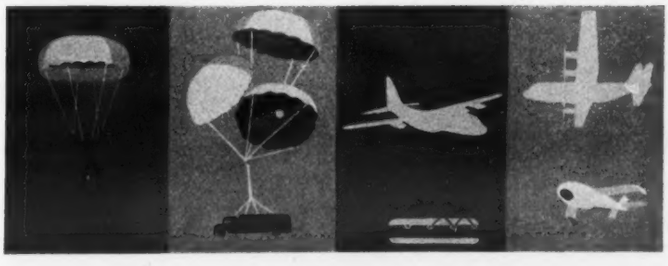
This illustration shows the Boundary Layer Control system of the Hercules. A pod under each wing carrying two small modified jet engines bleeds air which flows over all control surfaces, ailerons, flaps, rudder and elevator greatly reducing stall speed of the 61-ton transport.



Licensed manufacture

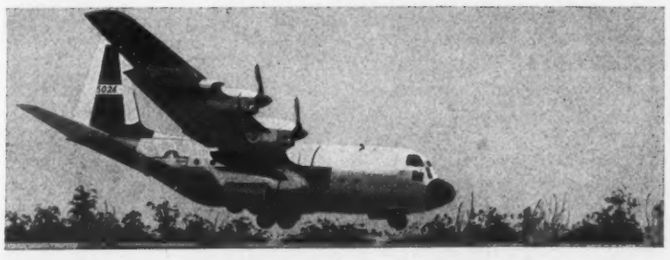
The Hercules is easily adapted to licensed manufacture. Plans for its production in Europe by a nation or nations co-operating with Lockheed have been carefully studied. Results emphasize spectacular saving of both money and time.





Versatility

The excellent range capabilities of the C-130 enable it to perform long search and patrol missions. Moreover, it can be easily adapted to many different mission configurations including Paratroop Drop, Aerial Cargo Delivery, Air Rescue, Drone Launcher / Director Aircraft, Troop Carrier, Air Refueling, Aerial Mapping and Surveying, etc.



Soft Field Take-off and Landing

The unique landing gear design of the C-130 permits it to operate from soft, unprepared fields. High gross-weight landing tests have been made on grass, sand and pierced steel plank. The C-130 is the largest aircraft to be equipped with skis for snow and ice landings.

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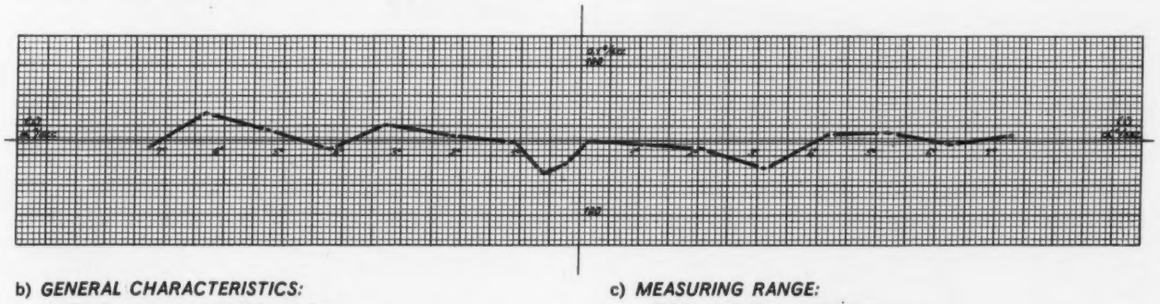
Modern aircraft armaments systems and missile guidance systems require highly sensitive detection devices.
S.F.I.M. has designed and developed a miniature gyrometer whose characteristics meet the demands of current advanced programmes, and the French armed forces are using this instrument.

a) The instrument enables angular rate measurements to be made by means of a cross-shaped leaf spring, the flexure of the spring being proportional to the precessional force of a gyro unit.



b) *GENERAL CHARACTERISTICS:*
- Kinetic moment: 569 lb/sq.in./sec
- Power supply: 26 volt, 400 c/s
- Starting time: 20 sec
- Basic noise:
  40 mV 3rd harmonic
  10 mV 90° out of phase
  40 mV gyro motor effect

c) *MEASURING RANGE:*
±40 °C ; ±60 °C ; ±150 °C
- Maximum deviation ±2.5°
- Linearity: ±2 % of measuring range
- Drift from zero due to temperature: 0.003 % per degree
- Maximum temperature: 100 °C

Research and Development

Instrumentation

Radio-electric direction finding

Pilotage, navigation and stabilization of aircraft and missiles

Flight Tests

Photographic recording equipment for civil and military aircraft

Sensors

Radio telemetry for aircraft and missiles

Gyrometers

Airborne Equipment

Gyro-compasses

ADFs

Oxygen regulators

Stall warning indicators

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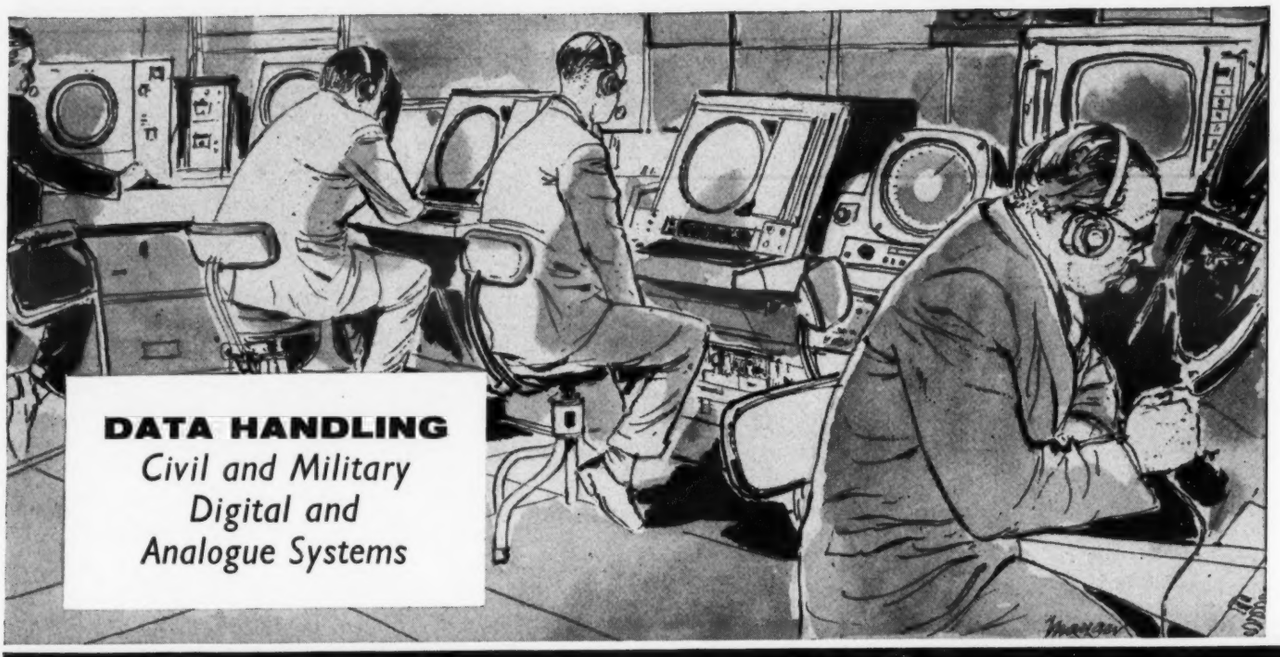

DATA HANDLING
Civil and Military
Digital and
Analogue Systems

MARCONI'S cover the

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The Marconi SNW 51 is designed to present accurate pictures of storms and rain producing clouds over ranges up to 200 n. miles. It meets the needs of Meteorological Departments and Civil Aviation Authorities, particularly where data gathering from distant recording posts is uneconomic or hampered by inaccessibility. It is used by the British Ministry of Aviation and in Australia, Southern Rhodesia, British East Africa and China. Its main features include: (i) Full off centring on displays; (ii) controlled camera recording facility; (iii) remotely controlled tiltable aerial; (iv) Iso-echo presentation.

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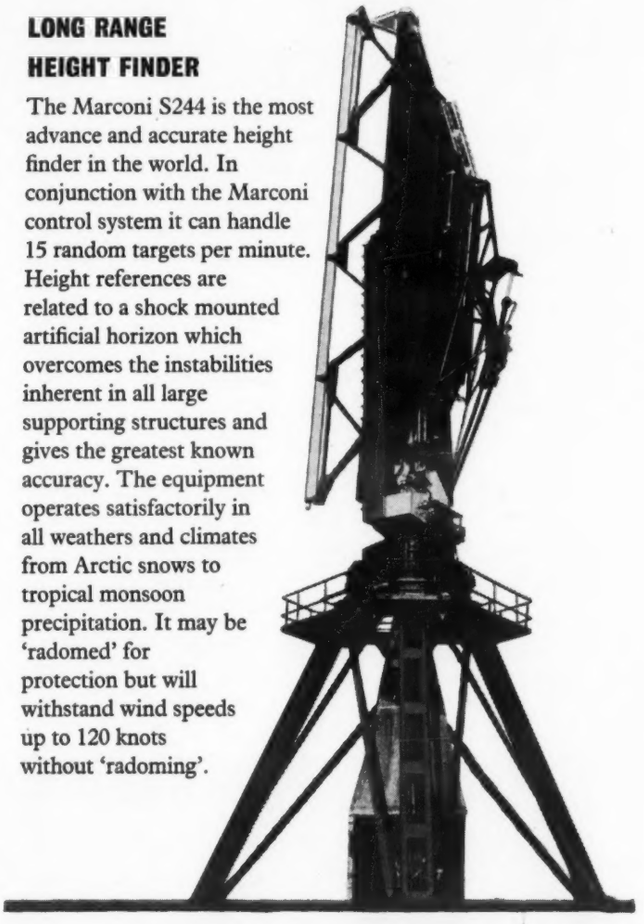
HEIGHT FINDER

The Marconi S244 is the most advance and accurate height finder in the world. In conjunction with the Marconi control system it can handle 15 random targets per minute. Height references are related to a shock mounted artificial horizon which overcomes the instabilities inherent in all large supporting structures and gives the greatest known accuracy. The equipment operates satisfactorily in all weathers and climates from Arctic snows to tropical monsoon precipitation. It may be 'radomed' for protection but will withstand wind speeds up to 120 knots without 'radoming'.



AIR TRAFFIC CONTROL SYSTEMS

The Marconi S264A 50 cm. radar is the most advanced air traffic control radar in the world. It will operate anywhere, including mountainous country, in all weather conditions. It is designed for the control of jet aircraft from take-off to 150 miles plus, combining the three roles of Airfield Control, Terminal Area Control and Long Range Airways Surveillance. Several versions are now available to suit varied circumstances and continuous research is being devoted to ensure continued progress and development of Marconi 50 cm. radars.

whole field of ground radar

LONG RANGE SURVEILLANCE RADAR

This versatile radar can be adapted to a diversity of applications. The Moving Target Indicator eliminates the echoes from stationary objects. Distortion of the reflector profile is prevented by the main member being a 6′ 8″ diameter tube, thus giving increased accuracy over a longer life. A unique mechanical design feature ensures that the turning gear is unaffected by slight subsidence of the site. Like the S244 the equipment is 'all weather' and 'all climate' and will withstand wind speeds up to 120 knots without 'radoming'.

Marconi's offer a complete consultancy and engineering service in the installation of radar systems. All Marconi radars and data handling equipment have been designed for integration into the most advanced air traffic control and defence systems at present in operation or contemplated in the foreseeable future. Marconi radar is in constant use in 36 countries.

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Complete Civil and Military Radar Systems

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. . . as an interceptor and ground attacker are those aircraft equipped with AIRPASS II, the new Ferranti dual purpose radar fire-control and navigation system.

For both ground attack and interception the navigation system is fully integrated with the radar and fire-control equipment.

AIRPASS II can be used with guns, rockets, guided weapons and all types of bomb.

Developed from the AIRPASS system now in full production for the Royal Air Force,* AIRPASS II is specified for the export versions of the English Electric 'Lightning', the Dassault 'Mirage' III and the SAAB 'Draken'.

INTERCEPTION	GROUND ATTACK
● RADAR SEARCH	● GROUND MAPPING
● AUTOMATIC TARGET TRACKING	● CONTOUR MAPPING
● COMPUTER CONTROLLED APPROACH	● TERRAIN CLEARANCE
● BLIND OR VISUAL ATTACK	● BLIND OR VISUAL ATTACK

* *Ferranti are also producing a radar for the Royal Navy's Blackburn NA.39 Strike Aircraft.*

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who have to travel with dignity, speed, comfort and privacy, the Executive version of this well-tried aircraft is an ideal and representative means of transport.

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who want speed mixed with comfort, luxury and reliability, the F. 27 is a most efficient flying office.

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THE F. 27 EXECUTIVE VERSION

helps all in very responsible positions to save time and strain by enabling them to continue their work while travelling.
This aircraft guarantees smooth and effortless flying in all weather, no matter how extreme, and its usefulness is multiplied by the fact that it can use a great variety of airfields, including those with short runways or rough surfaces, with a minimum of servicing and maintenance.

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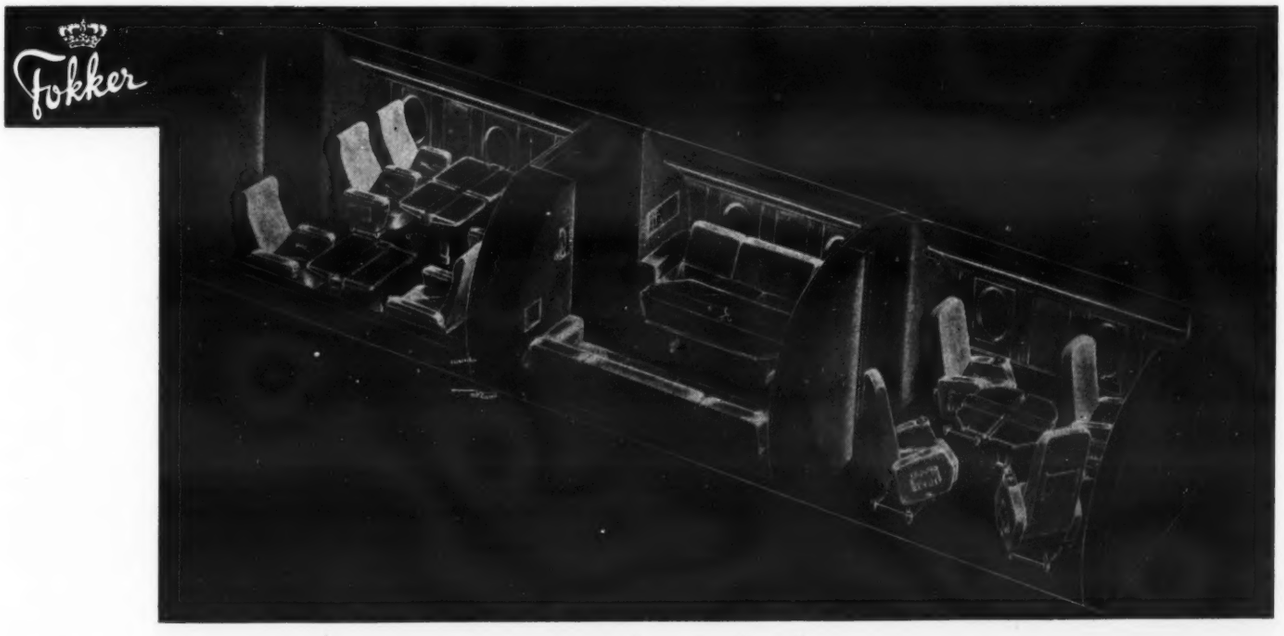
world-famous Dart turboprop engines which had flown 10,000,000 hours by the end of 1959, the F. 27 Friendship is an aircraft thoroughly proved in regular service not only by regular airline operators but also by business executives all over the world.



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Following upon experience gained with Aeroweb in the Viscount, Vickers-Armstrongs have used this metal honeycomb in many parts of the Vanguard, including the elevators.
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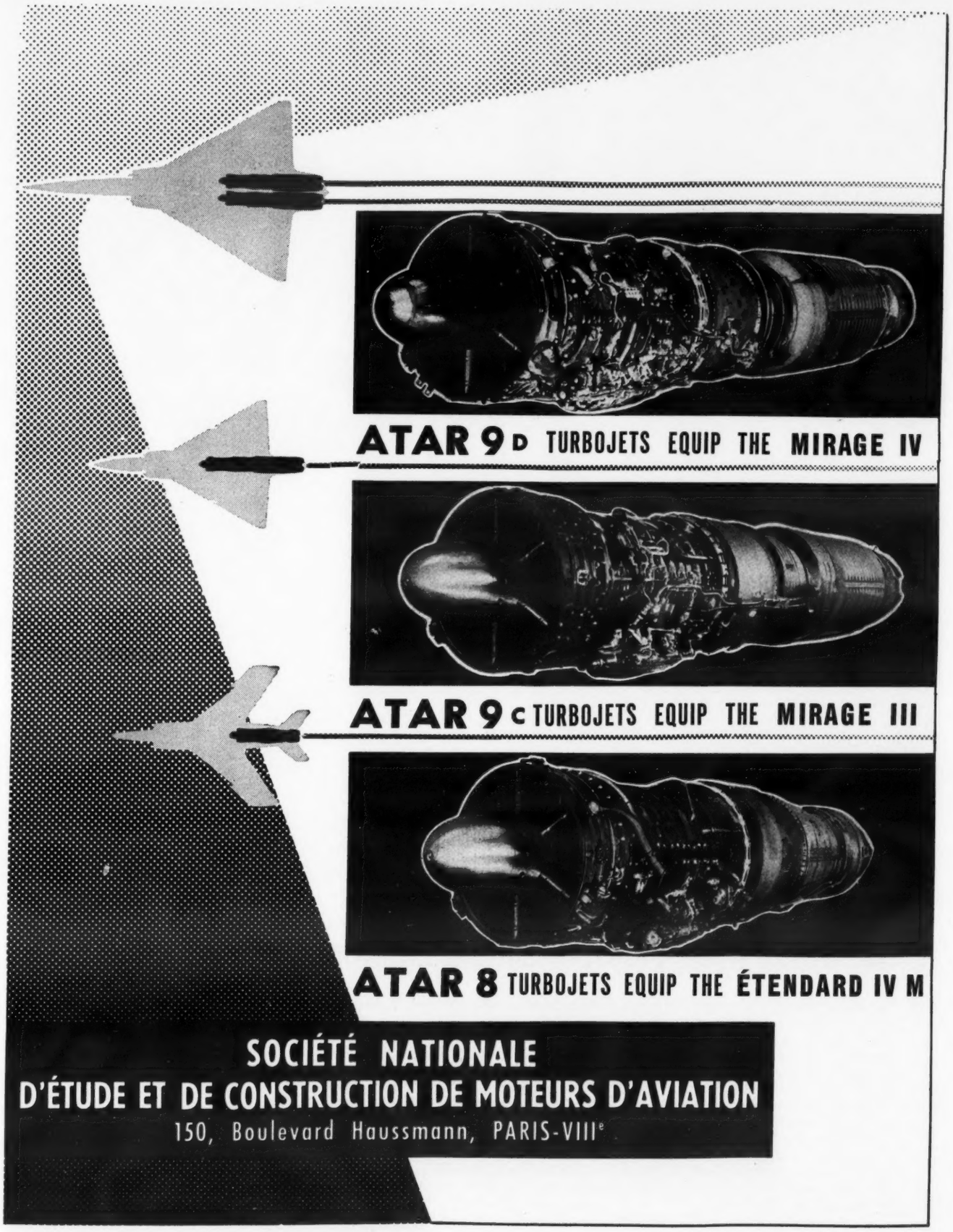
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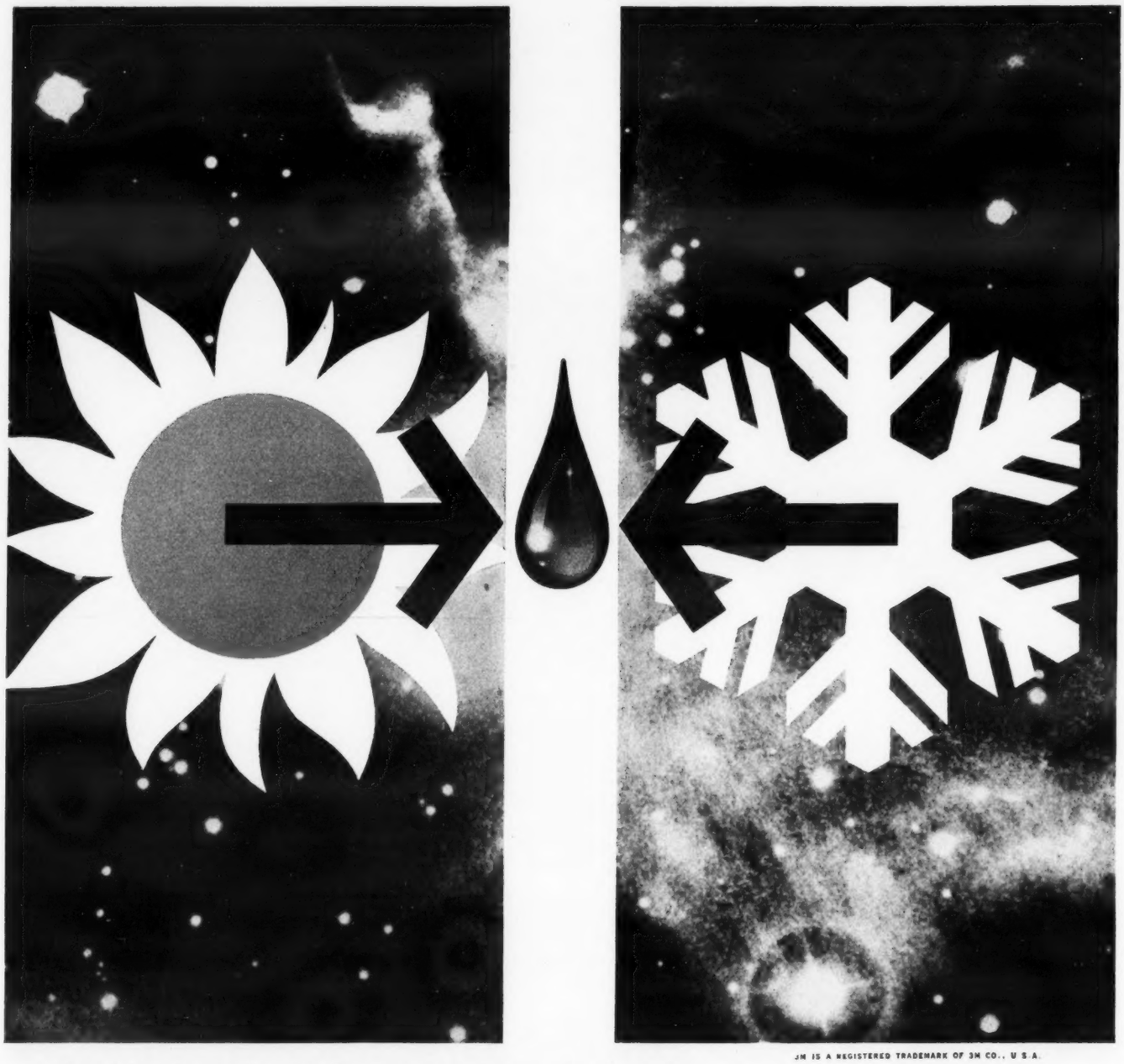

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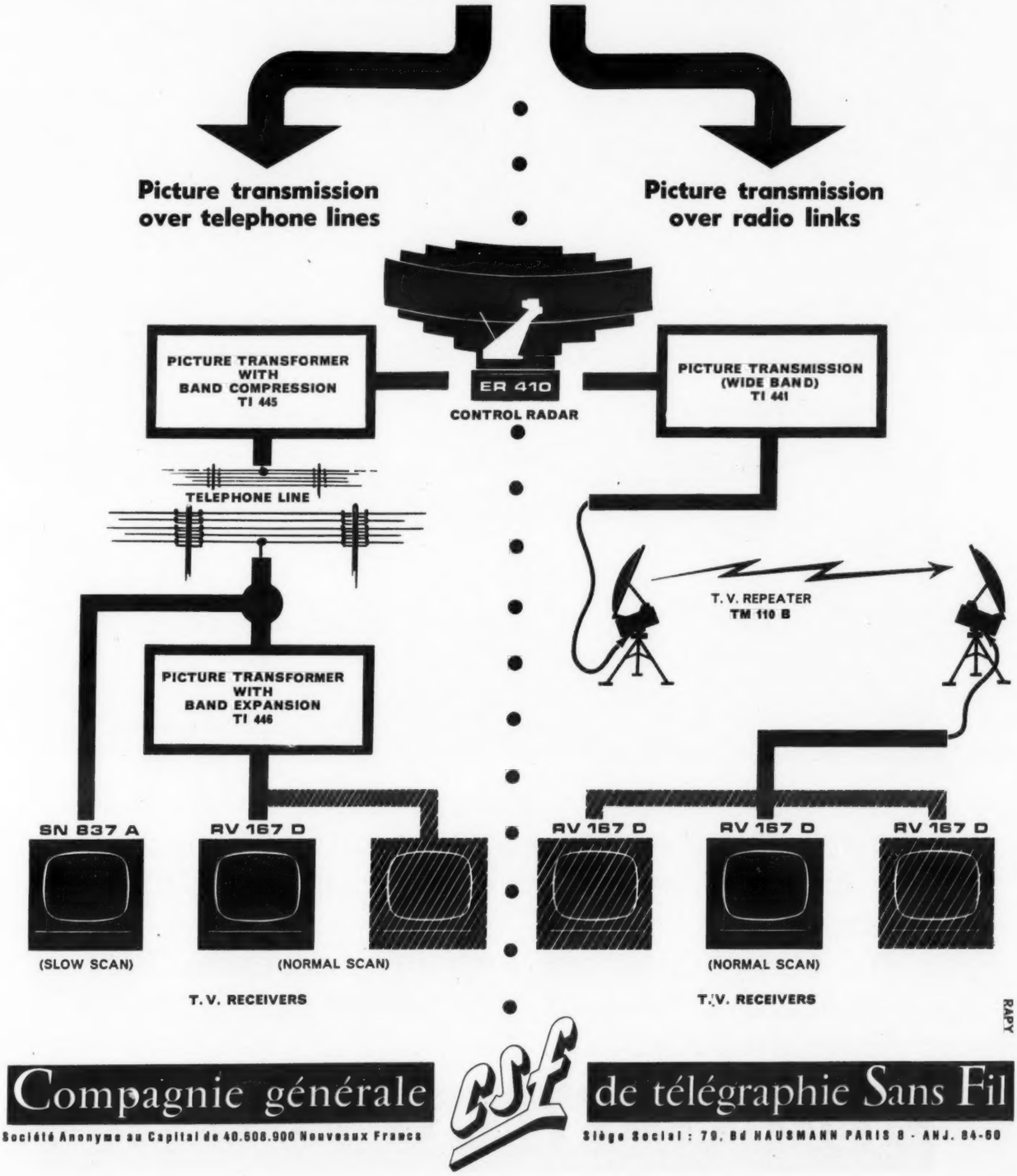
BOEING 720

AIR TRAFFIC CONTROL

two solutions by CSF

for the transmission and utilisation of radar pictures



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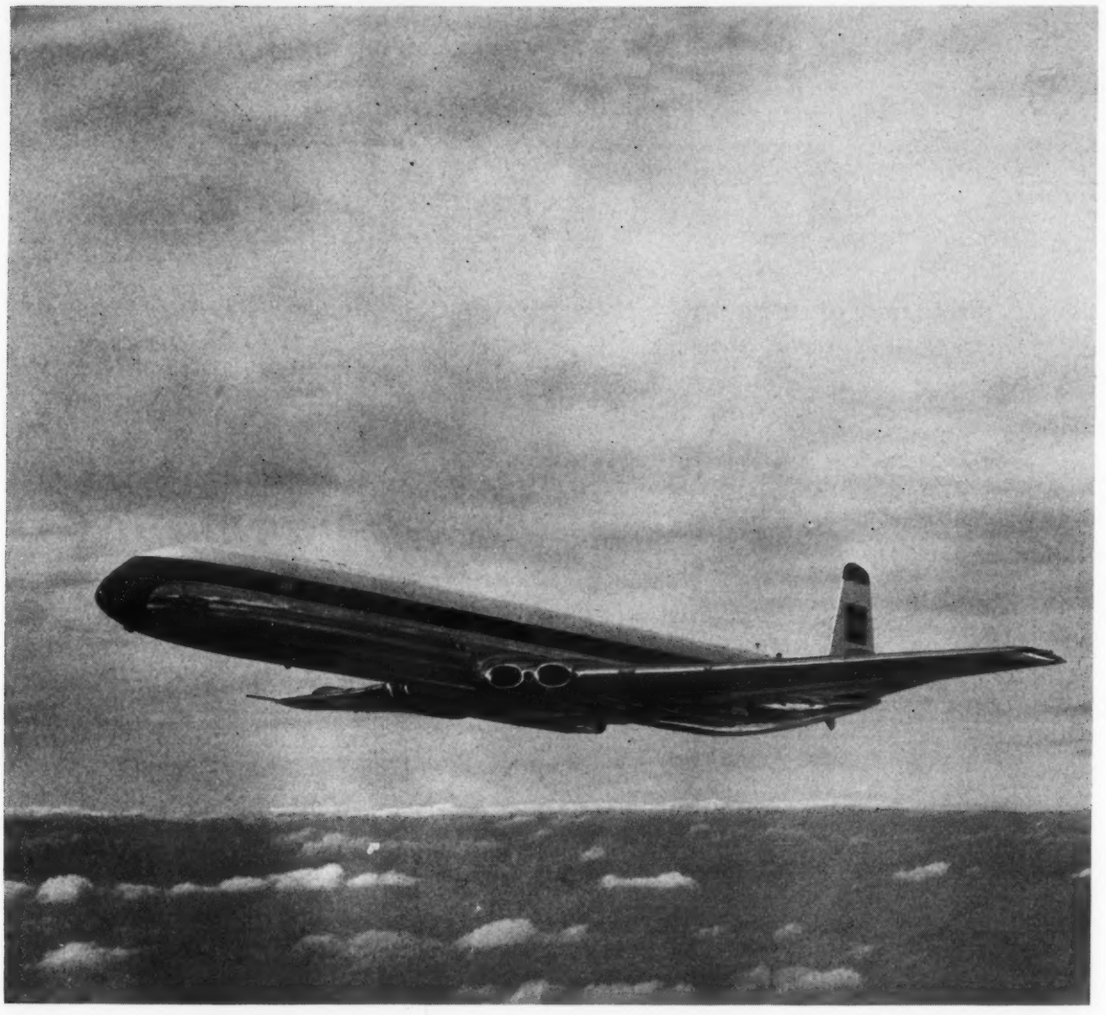
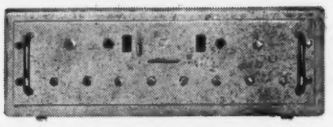
BEA carried 3,289,606 passengers IN ONE YEAR



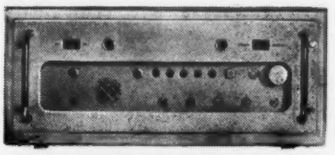
3,289,606 passengers were flown by BEA in 1959/60. 1,864,122 on International flights—1,425,484 on services within the United Kingdom.

To carry these millions of passengers BEA operate a fleet of 100 airliners—Europe's Foremost Airline.

BRITISH EUROPEAN AIRWAYS



Crystal-controlled single-channel receiver, type 8RO 509



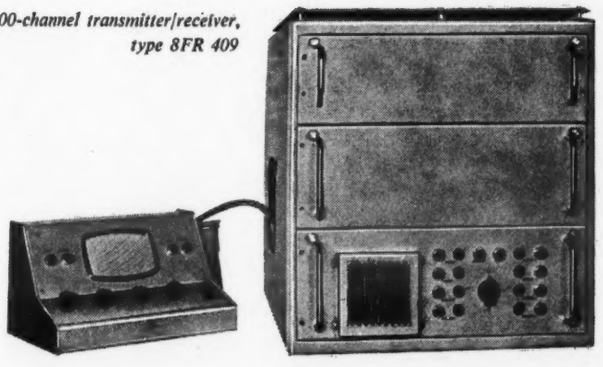
15 W crystal controlled single-channel transmitter, type 8RZ 509

UHF

Ultra High Frequency

PHILIPS

3500-channel transmitter/receiver, type 8FR 409



The steady expansion of civil and military air traffic necessitates equipment of higher standards for aeronautical communication systems. To meet this demand, Philips has developed an extensive range of equipment for UHF voice communication in ground-to-air, ship-to-air or ship-to-ship networks.

In this equipment high stability and utmost reliability are combined with great flexibility and ease of operation, as a result of modern thinking and long, world-wide experience in the field of telecommunication.

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WITH THE VERTOL 107-MODEL II

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Airline operation is only one of the many applications for the Vertol 107-Model II. Its twin-turbine reliability and ease of handling—its altitude and speed characteristics—its water-landing capabilities—its extra-large cargo capacity and straight-in rear loading—its ability to haul loads internally, externally or half-in, half-out—all add up to new speed, new dimensions in versatility and new economy for many commercial and industrial applications such as petroleum, mining, logging, and construction.

For complete details on the Vertol 107-Model II, write: Commercial Sales Manager.

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EKCO dual-system lightweight weather radar

Weather Radar, already mandatory in some areas, will become essential equipment in many types of aircraft. A dual system is the obvious way to guard against the possibility of grounding due to equipment failure.
Now, aircraft can be fitted with a dual-system involving a total weight of only 103 1bs—yet providing maximum performance and operational efficiency.
Ekco Lightweight Weather Radar which makes this possible, has been achieved by the extensive use of transistors. The Ekco dual-system employs two Transmitter/Receivers, two Indicators, a Scanner and Junction Box—and weighs less than competitive single systems ! It not only saves space and weight but also reduces total power consumption to less than half that required by 60 kW systems.

See Ekco Dual-System Lightweight Weather Radar at the S.B.A.C. Farnborough Exhibition together with Automatic VHF/DF *Equipment ; Airfield Approach Aids ; Transistorised Inverters.*

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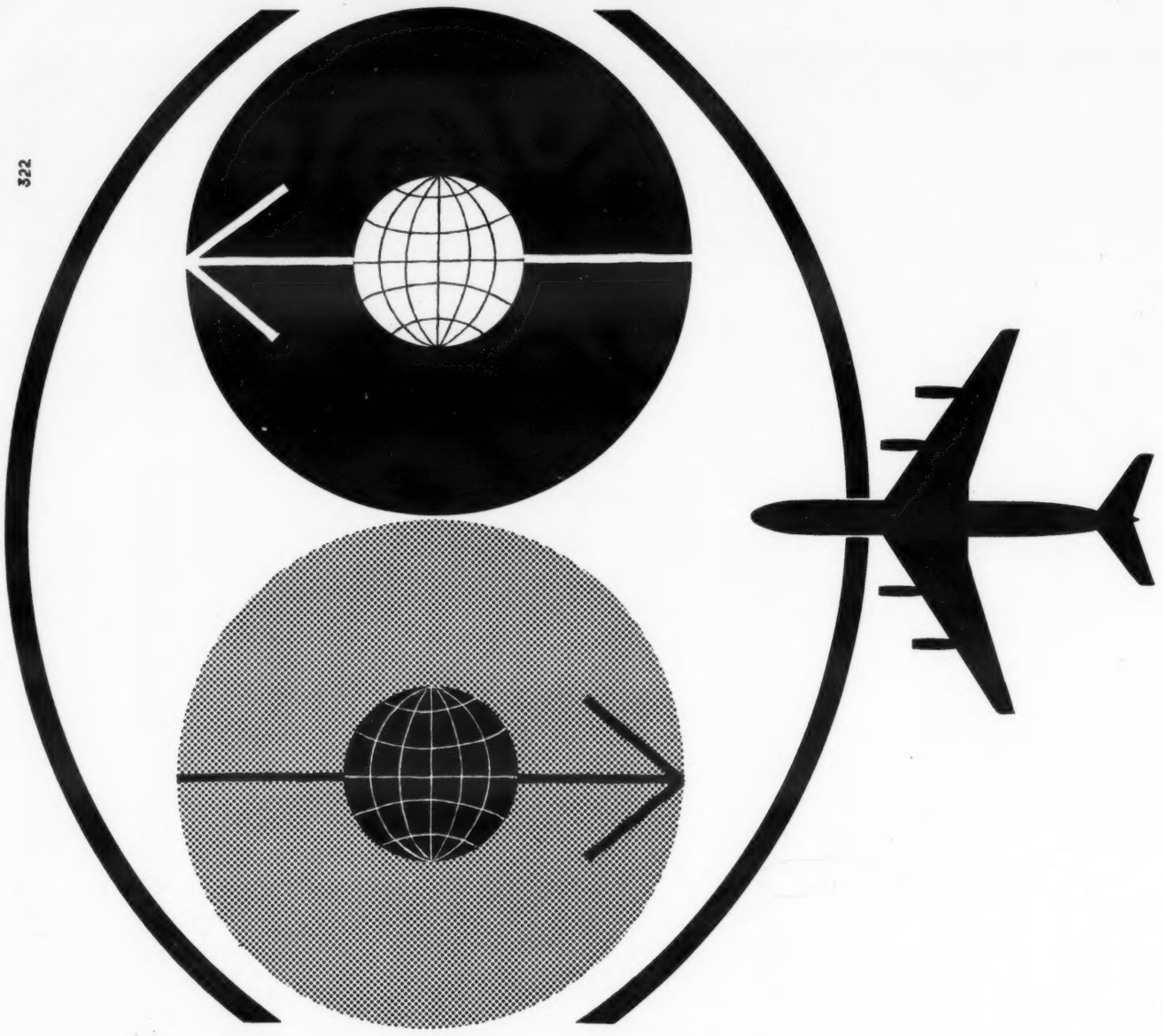
PYE

INSTRUMENT LANDING SYSTEMS

Pye Telecommunications Ltd · Newmarket Road · Cambridge



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You can buy your LUFTHANSA ticket at any IATA travel bureau.

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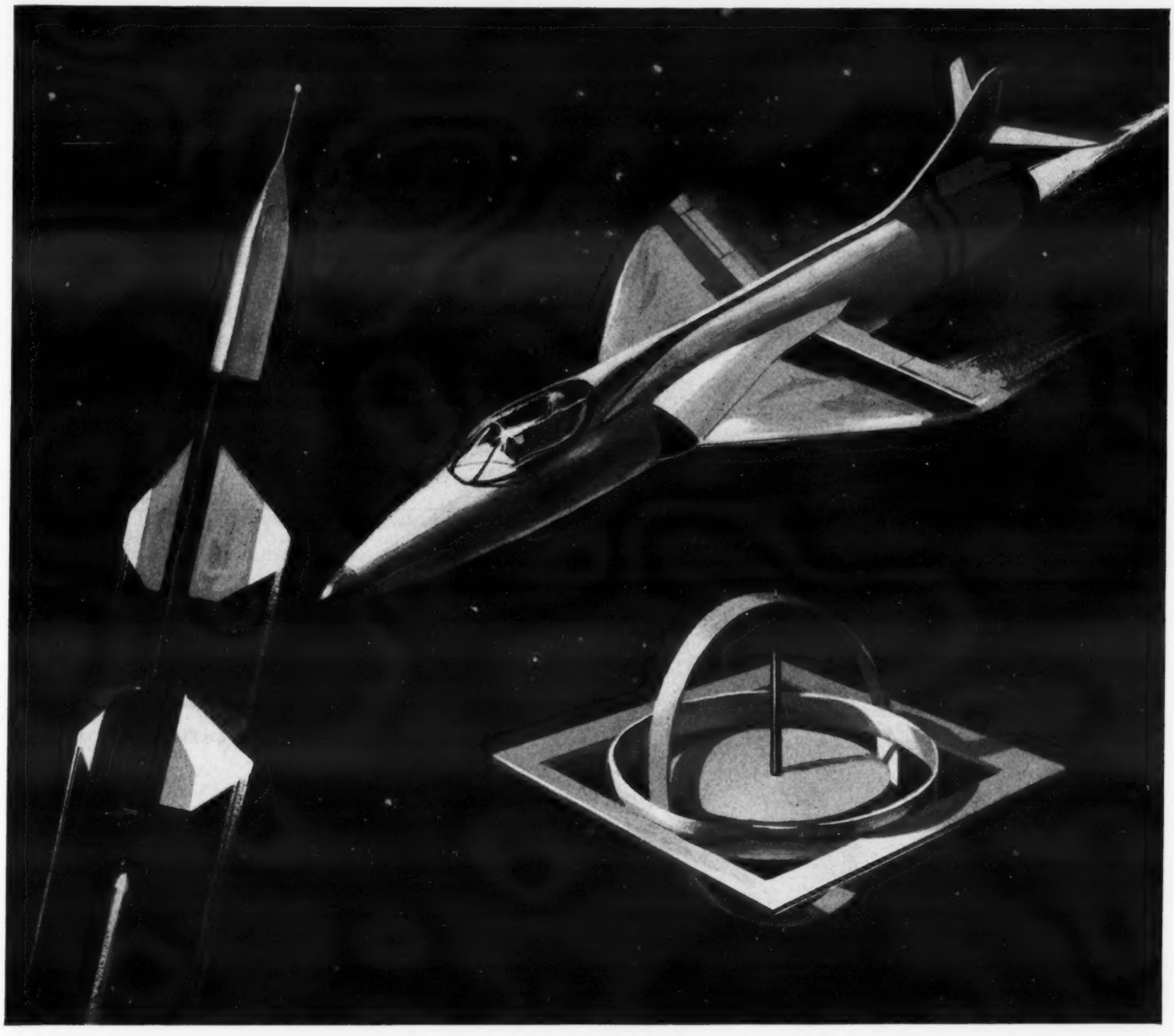

20-pound inertial platform

By a precise balancing exercise, this silent, sleepless "pilot" will keep its craft on course as it streaks through space. The miniature, all-attitude inertial platform detects any pitch, roll or yaw deviations and is the heart of a precise navigation system.

The best news of all concerning this new inertial platform is Norden's success in achieving higher accuracy and reliability...in a significantly smaller package. The unit measures a mere $7^{7}/_{8} \times 9^{3}/_{8}$ inches and weighs less than 20 pounds. It offers optimum state of the art wherever stabilized spatial reference is required. This engineering accomplishment once again underscores Norden's capability in the fields of digital computing... gyro design and application ...reliability techniques... and precision manufacturing.

Norden also offers a complete line of servo components, analog to digital converters, numerical control systems, and other electronic equipment for a wide variety of military and commercial applications.

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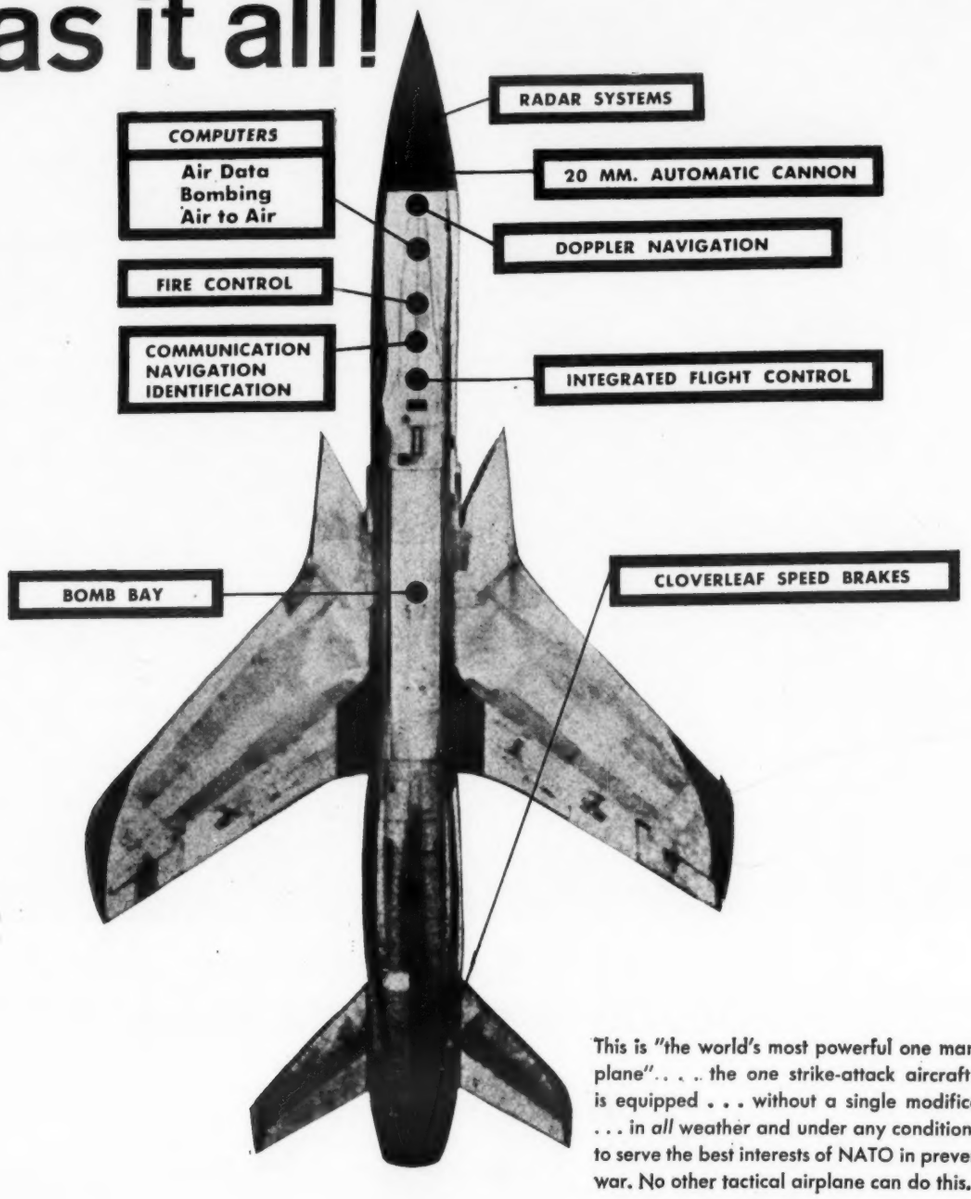
only Republic's F-105 has it all!



This is "the world's most powerful one man airplane". . . . the one strike-attack aircraft that is equipped . . . without a single modification . . . in *all* weather and under any conditions . . . to serve the best interests of NATO in preventing war. No other tactical airplane can do this.

Consider, too, Republic's "Mission Plan": the establishing of a prime source of supply in Europe for the production of this supersonic, nuclear armed jet by various European industrial firms throughout NATO.

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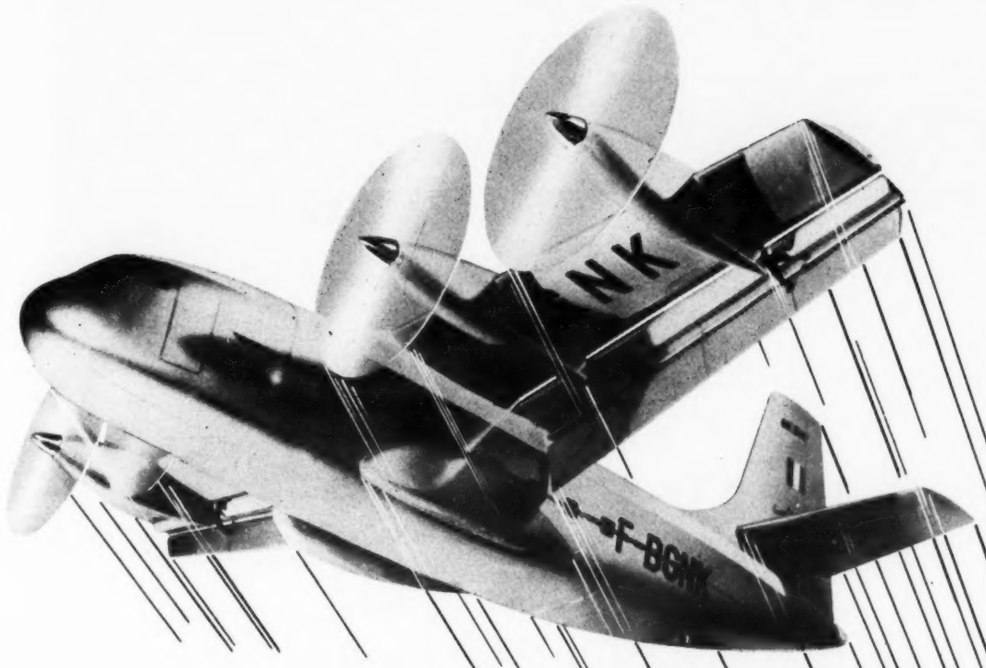

- for take-off and landing on very rough terrain
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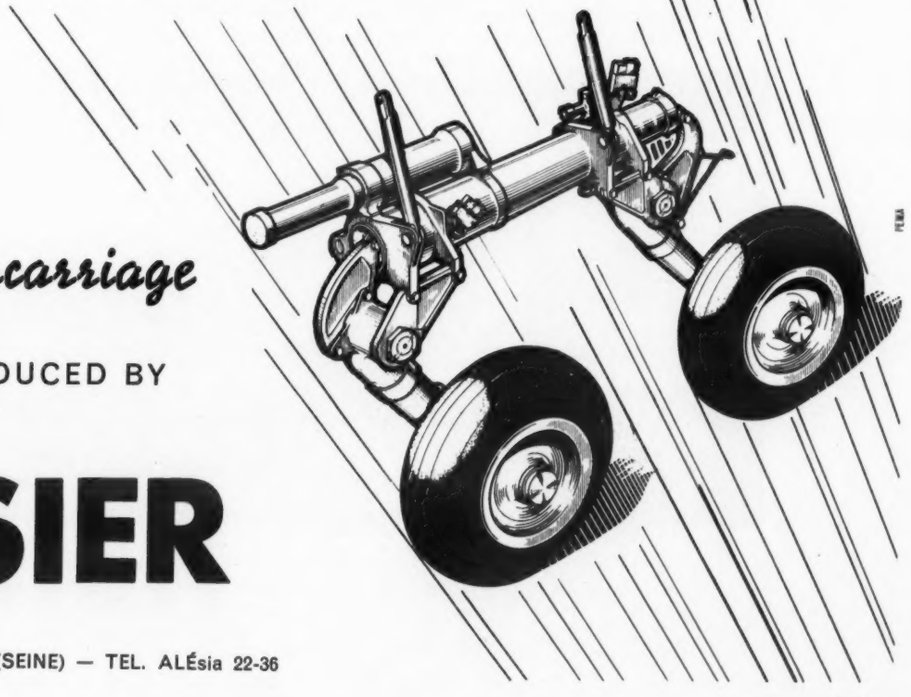

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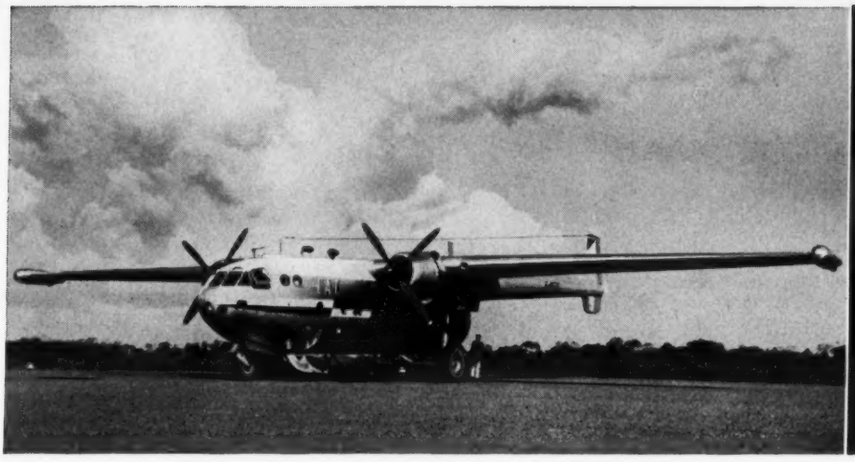

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RADAR

50 cm Gives longer range for given transmitter power.
The Marconi series of 50 cm radars gives clearance of jet aircraft from take-off to 150 miles plus on a power of only 500-600 kW. The one radar meets both airways surveillance and air traffic control requirements. Running costs are thus much lower.

50 cm Penetrates thick weather without loss of efficiency.
In most radars precipitation clutter seriously obscures the PPI picture. No remedial device is 100% efficient. The choice of the 50 cm wave length, however, avoids the difficulty entirely. It gives a clear picture of aircraft, even in heavy rain or snow, and also indicates the position of storm centres.

50 cm Permits M.T.I. elimination of permanent 'clutter'.
Of the various ways of clearing the echoes of stationary objects which confuse the interpretation of the radar situation, M.T.I. (moving target indication) undoubtedly gives the best results. The use of 50 cm makes it possible to use crystal control throughout a radar system to which a simple and completely stable M.T.I. can be harnessed to give a clear and unambiguous picture.

50 cm Switches into instant operation.
Crystal control of frequency enables Marconi 50 cm radar to be brought into instant operation even after long periods of inactivity.

GIVES THE LONG, CLEAR VIEW

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SURVEYED, PLANNED, INSTALLED, MAINTAINED

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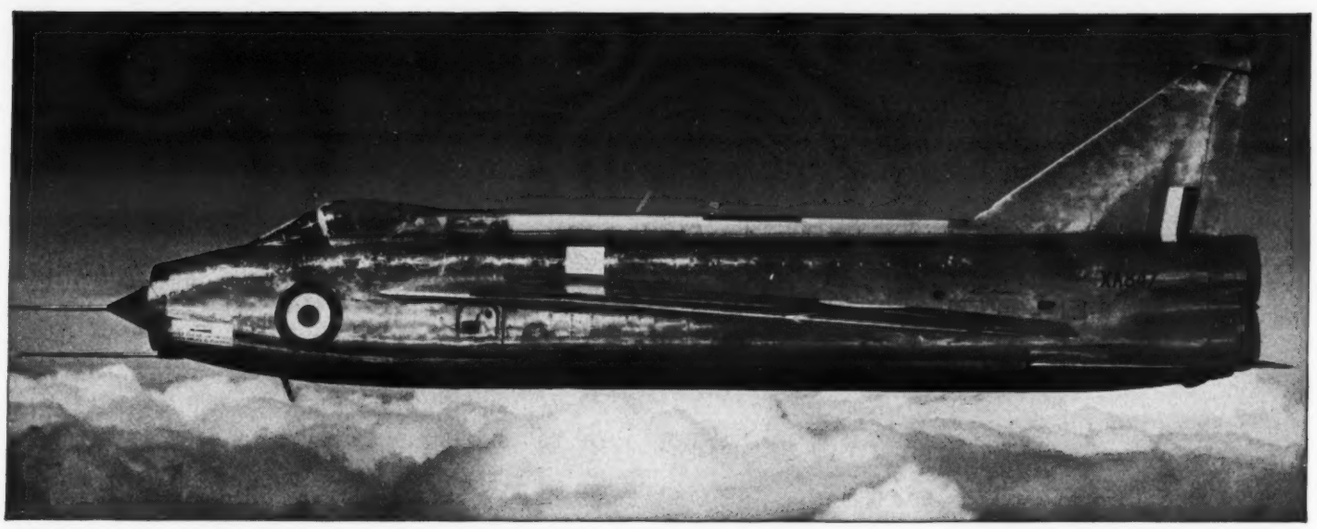
The ENGLISH ELECTRIC Lightning has the basic safety factor of all twin-engined aircraft. In addition, all its powered control systems, and their power supplies, are duplicated. It can, if required, extend its range by cruising on one engine alone, for it poses no asymmetrical flying problems. And it can go supersonic in level flight without re-heat.



...THE LIGHTNING IS INCOMPARABLE

'ENGLISH ELECTRIC' aircraft

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Foreword to Farnborough

The Rt. Hon. Harold Watkinson, M.P.
Minister of Defence

The Rt. Hon. Peter Thorneycroft, M.P.
Minister of Aviation

I am glad to accept this invitation to set out the main points of Britain's defence policy. It is an appropriate subject for the Farnborough Display: the aircraft industry plays a vital part in implementing the policy.

Our object is to prevent war. To this end, we are maintaining a contribution to the nuclear deterrent strength of the West, providing shield forces for NATO, playing our part in the other regional alliances, and meeting our Commonwealth and other obligations throughout the world.

We have decided that as we are so near the missile front-line, we cannot plan to rely for our contribution to the deterrent on weapons fired from fixed bases in the United Kingdom. We must secure the greatest possible mobility and flexibility and, for this reason, we shall continue to use the modern jet aircraft with its great range and mobility as an integral part of our nuclear weapon system. Our nuclear deterrent is at present maintained by the Mark I "V" bombers with the free-falling bomb. They are being succeeded by the Mark II "V" bombers which will carry the *Blue Steel* powered guided bomb, and at a later stage the *Sky Bolt* ballistic missile. With these weapons, we shall be able to maintain a mobile contribution to the Western deterrent until at least 1970.

Forces armed with "conventional" weapons are an essential complement to nuclear forces. At the end of this year, the last national servicemen will be called up and we shall thereafter rely increasingly on smaller all-regular forces. They are being armed with the most up-to-date weapons and are being given the highest possible degree of mobility so that they can quickly be available to support our partners in NATO, CENTO and SEATO and meet any other demands which are made on them throughout the world.

By the end of 1960, the world-wide capacity of RAF Transport Command will amount to near 150 million passenger-miles a month at normal utilization rates. In an emergency, this capacity could be very greatly increased.

The threat of war takes many and changing forms. Our defence policy must be flexible to meet changing circumstances. We intend to ensure that whatever threat arises we shall be ready, in cooperation with our Allies, to meet it.

British aircraft and guided missiles coming into service and under development are essential to all phases of this policy. They enable us to maintain an independent nuclear deterrent and provide many of the up-to-date weapons with which our forces are being armed; British aircraft will give us the mobility necessary to meet our world-wide responsibilities.

Harold Watkinson

The flag of British aviation will fly high over Farnborough in 1960. In the past year there has been a radical reorganization of the British aircraft industry. Today it stands poised to re-capture the impetus and inspiration which won Britain for all time the Schneider Cup Air Speed Trophy before the war, gave the world radar and the jet engine, and produced the first gas turbine civil aircraft in the shape of the *Comet* and the *Viscount*.

To some degree perhaps British aviation faltered in its stride following the luckless *Comet* disaster and the over-weening demands made on its resources by cold war rearmament and the Korean crisis.

In parallel the emergence of new weapons such as rockets involved a reorientation in the military field. All this led to a period of somewhat painful readjustment in a highly competitive business as risky as it is exciting.

The successful reorganization of the industry, however, into two major airframe companies, two major engine companies and a helicopter enterprise, all possessing the financial and technical resources demanded by the ever-increasing cost and complexity of modern aircraft in a heavily competitive market, has been achieved.

There has been ready recognition within the industry of the pressing need for this concentration of resources. The consequent re-grouping will enable the British aircraft industry both the better to meet the needs of modern defence and to compete effectively throughout the world.

The Government has played its part in promoting these developments by recognizing the need for material assistance in the form of taking a share of the heavy investment risks involved for the industry in respect of even the most promising aircraft and engine projects in the civil field.

Thus the industry faces the 1960s from a position of renewed strength with a balanced pattern of advanced civil projects and in the knowledge that the country is well to the forefront in the development of many most significant projects. Vertical or short take-off and landing machines, for example, and navigational developments like "Blind Landing" equipment, promise to revolutionize civil air transport, not least in a sphere of future supersonic flight.

The enterprise of *Interavia* in their annual introduction to the Society of British Aircraft Constructors' Display at Farnborough is commendable. People from all over the world will be visiting the Display; and through the columns of *Interavia* thousands of others, not so fortunate, will yet be able to see how the British aircraft industry is meeting the challenge of the time.

Peter Thorneycroft

RAF Bomber Command in the Sixties

British defence policy has been the subject of a major upheaval in 1960, with the cancellation of the Blue Streak *and the agreement with the United States to purchase the* Sky Bolt. *A pattern is, however, emerging which, if not subjected to constant governmental change and Treasury axing, will give versatility and a hard-hitting punch in both the nuclear and non-nuclear fields.*

The essence of the British deterrent and local war suppression for the next ten years will be flexibility. With a limited budget, Britain has got to maintain a highly efficient deterrent and at the same time be able to send top quality equipment with the latest conventional weapons to any part of the world where a "forest fire" breaks out. This is being accomplished by improving the internal equipment of the "V" bombers, expanding electronic counter-measures, and putting the main weight of the strike into the air-to-surface weapon.

The Vulcan Mk.1 *and* Victor Mk.1 *are now fully established in service and are thoroughly reliable, while the* Vulcan Mk.2 *with advanced counter-measures, uprated engine, etc. is now going into service and will be followed by the* Victor Mk.2. *At present unguided atomic or thermonuclear weapons can be carried for direct dropping over the target. In the next stage, now beginning, the Mk.2 bombers will carry the 500-mile range* Blue Steel *supersonic stand-off guided bomb. This will take Bomber Command to 1965, when the build-up of the East's ballistic weapons and development of its defences will necessitate some change in policy.*

The deterrent with its dispersed British bases can up to that time get sufficient aircraft airborne on a short alert to do tremendous damage and make an enemy nuclear attack a doubtful enterprise. In 1965 the RAF can expect to begin the change-over to the Sky Bolt *airborne ballistic weapon. With this the problem of improved defences by a potential enemy will be countered by the ability to deliver a warhead at a stand-off range of over 1,000 miles around the whole of a long perimeter, and it is in the late 1960s that the theory of dispersal, in coordination with the USAF Strategic Air Command, will really come into its own.*

In addition to the Sky Bolt*-equipped* Vulcans, *Bomber Command will also employ other "V" bombers carrying a developed version of* Blue Steel *with more range; plus high-speed low-altitude attack using the British Aircraft Corporation's TSR.2 aircraft.*

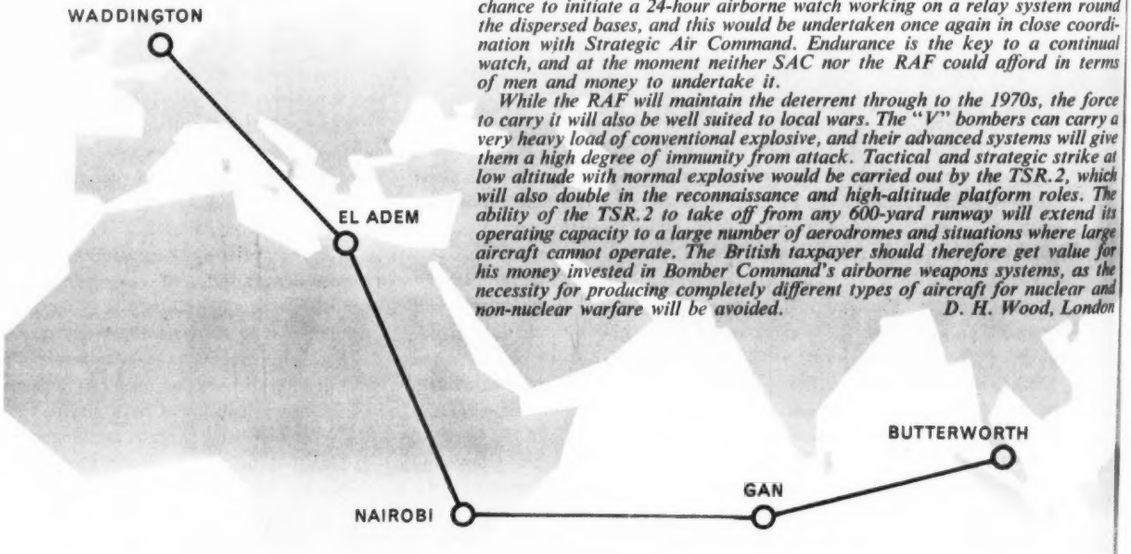
Thus an enemy will be faced with a force able to deliver ballistic, cruise, and low-altitude weapons from a variety of directions. This combination with advanced counter-measures and decoys will stretch enemy defence to the maximum to deal with all three forms of attack simultaneously, particularly when it cannot be ascertained from the radar screen which type of attack is on its way in. To provide full-scale perimeter and special target defence against all three would be almost beyond the capacity of any nation covering a very large land mass.

Beyond the present "V" bombers it is intended that there should be another large aircraft, not supersonic but with the emphasis on endurance, and here a choice between a developed Vulcan *and a military version of the Super VC.10 is probable. An endurance of 20 hours or more will give Bomber Command a chance to initiate a 24-hour airborne watch working on a relay system round the dispersed bases, and this would be undertaken once again in close coordination with Strategic Air Command. Endurance is the key to a continual watch, and at the moment neither SAC nor the RAF could afford in terms of men and money to undertake it.*

While the RAF will maintain the deterrent through to the 1970s, the force to carry it will also be well suited to local wars. The "V" bombers can carry a very heavy load of conventional explosive, and their advanced systems will give them a high degree of immunity from attack. Tactical and strategic strike at low altitude with normal explosive would be carried out by the TSR.2, which will also double in the reconnaissance and high-altitude platform roles. The ability of the TSR.2 to take off from any 600-yard runway will extend its operating capacity to a large number of aerodromes and situations where large aircraft cannot operate. The British taxpayer should therefore get value for his money invested in Bomber Command's airborne weapons systems, as the necessity for producing completely different types of aircraft for nuclear and non-nuclear warfare will be avoided. *D. H. Wood, London*

Vulcan's Apprentice

By Edward K. Barnes,
Interavia, Geneva



"Exercise X"—being fully aware of the magic of a name, the first preoccupation of the Planning Staff is usually to find a sufficiently obscure code name which gives no indication of the aims of the operation. Obscurity or security is no doubt the intention and in this they succeeded handsomely when selecting a suitable name for this particular exercise. Now that it is completed, it is sufficient to say that the vital name covered the movement of four *Vulcan Mk. I* aircraft of the Royal Air Force on a training flight from their base in the United Kingdom to Malaya, and after a fortnight spent in flying in tropical conditions, their return to the U. K.

It is to be hoped that the Planning Staff of RAF Bomber Command will forgive this oversimplified description. As I was a passenger on board one of the aircraft for the outbound journey I can only make amends by saying that the trip was carried out with the smoothness and lack of incident which is the hallmark of planning.

It should be emphasized at the outset that this was a training exercise. No attempt was made to break any records for the flight between Great Britain and Malaya, and each sector of the route was selected so as to offer the maximum training facilities. Although our progress to the Far East could not be described as leisurely, it was greatly below the optimum capabilities of both the aircraft and the crews. Bearing this factor in mind emphasizes the potential mobility of the force and the relatively short time which would be required to deploy a force of V bombers on the other side of the world.

For myself, taking part as observer, reporter, passenger or dead weight—my crew

selected the appropriate terms at various stages during the trip — the exercise began on the day before take-off with an enforced visit to the RAF Central Medical Establishment for a medical board. There, twenty years of my medical history were unearthed from the archives and the examiners proceeded to add another page of unbiased opinions on my health. Apparently the opinions continued to be favourable, for within two hours (possibly, a record for the course) I left in possession of the all-important RAF Form 624, certifying me fit to fly in high-performance RAF aircraft, subject to a successful decompression test.

From the Central Medical Establishment in London the next stage was by train to Lincoln for the RAF Station, Waddington. Here the final requirements of the medical board were met with, and I was suitably decompressed to the satisfaction of the Station Medical Officer. The actual decompression test consists of a period spent at a simulated altitude of 25,000 feet in a low pressure chamber. The test fulfils several functions: apart from detecting any physical defects which may become apparent at high altitudes, such as pains in the joints from nitrogen concentrations in the blood or ear defects, it also offers an opportunity for quiet reflection on the sort of face the manufacturer of the oxygen mask had in mind when deciding the ultimate shape of the mask. Observation of many RAF aircrew convinces me that the individual with a snub nose, prominent cheekbones, sunken cheeks and a receding chin is practically non-existent or has at least left the Service. His oxygen mask remains, however.

The time passes quickly; the medical staff on the outside of the chamber maintains a constant watch on the inmates through the inspection ports, and regularly over the intercom there comes an enquiry as to one's welfare and whether any painful symptoms are making themselves apparent. Failing an affirmative answer—the test continues. For my part I would prefer to maintain a steady flow of enquiries to the operating staff. Thoughts of jammed valves and uncontrollable pumps bring to mind visions of being pneumatically locked in this metal dungeon indefinitely. A little reassurance that their side of the equipment was functioning perfectly would work wonders for the peace of mind.

Once the decompression test was finished I was officially certified fit and was taken in charge by the Station Intelligence Officer, who provided me with the final details concerning the exercise.

Briefly these details were as follows. Four *Vulcan Mk. I* aircraft belonging to 83 Squadron, based at Waddington, would leave the following morning for Malaya. The route followed would be Waddington–El Adem (Libya)–Nairobi–Gan–Butterworth (Malaya). Each leg of the route would be treated as a separate training exercise, and the aircraft would night stop at the three intermediate points. The force would be self-supporting en route with the exception of the refuelling facilities available at the stopping points, and a support party of technicians and tradesmen would follow the force in a *Comet* and *Britannia* of Transport Command to provide servicing facilities during the two weeks' stay at Butterworth. The Force Commander was Group Captain D. Iveson. Station Commander RAF Waddington, with Wing Commander L. F. Banks, Squadron Commander of 83 Squadron as Deputy Force Commander.

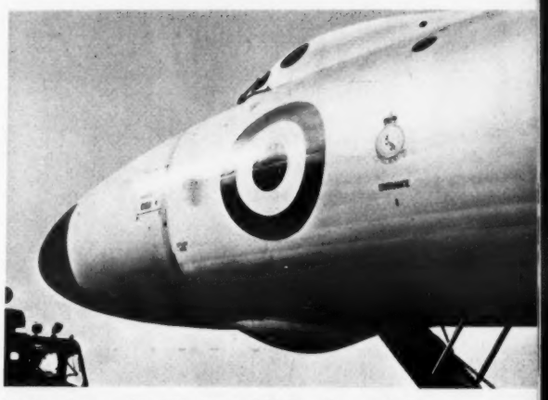
With this outline of the programme for the succeeding days I was handed over to Squadron Leader P. Ward, "B" Flight Commander, 83 Squadron, who provided more detailed information about the trip and then introduced me to Flight-Lieutenant Conway, captain of the aircraft in which I was to fly. My briefing was then completed in the active surroundings of "Vulcan's Forge"—an aptly named and furnished annexe to the Officers' Mess.

The first day

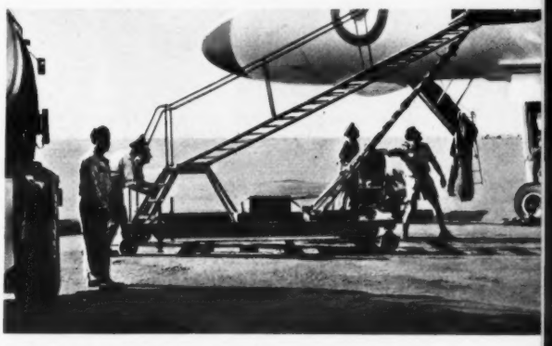
The following morning the exercise commenced in earnest. After meeting the complete crew: Flt. Lt. Conway (Captain), Flg. Off. Humphries (Co-pilot), Flt. Lt. Elmey (Navigator), Flg. Off. Doyle (Bomb Aimer) and Flg. Off. Hall (Air Electronics Officer), I was then introduced to the *Vulcan*. Climbing the entry ladder one finds oneself in a small semi-dark compartment; at the rear a raised platform with three rearward facing seats extends over the width of the fuselage. In front of the seats is the desk occupied by the Bomb Aimer, Navigator and Air Electronics Officer. Facing these three crew members is an array of black boxes, dials, indicators and radar scopes. Forward a ladder gives access to the cramped flight deck with ejector seats for the pilot and co-pilot. Beneath the flight deck a tunnel lined with equipment racks leads to the bomb aiming window. On each side of the compartment a step designed for the sextant position had been modified to form a seat for passenger carrying. The occupant of the other seat was to be Chief Technician Wildes, the aircraft Crew Chief. After a brief examination of these quarters, and a first acquaintance with the sharp corners and unexpected projections which were to extract a steady toll of scratches and bruises during the next four days, I went with the crew to the preflight briefing.

As the main operation briefing had been done the day before, this was of short duration. Last minute instructions concerning order of take-off, radio frequencies, and details concerning the bombing exercise which was to be carried out during the first stage of the journey. The Met. Officer took the stage to give the latest weather and the landing forecast for El Adem, and was met with the usual range of facial expressions and comments running from polite disbelief to incredulity. The briefing completed, the crew loaded an enormous quantity of assorted equipment, map bags, sextants, flight rations, flying overalls and personal possessions, including a gallon jar of water, into the crew bus and we went out to the aircraft dispersal. The water jar was a particular foible of this crew, and later events proved its worth.

Arriving at the aircraft, this mountain of equipment was finally stowed aboard, and I settled into my seat. Once the crew, was in position the preflight check list commenced. Listening to this on the intercom gave me the impression of listening to a play under re-



Marks of ownership. The crest of 83 Squadron and the motto "Strike to Defend." The RAF roundel and, in small print beneath, the name of the undisputed proprietor of the aircraft—the crew chief—Chief Technician Wildes!



Self help. On arrival at El Adem the crew commence the aircraft servicing under the speculative gaze of the local tanker driver.

Single-handed. Flg. Off. Doyle fits the blanking covers to the air intakes while Flg. Off. Humphries assists with advice.

Eight of the eighteen wheels. The shade of the delta emphasizes the long, hot walk to the El Adem Transit Mess in the background.

"...minions of the moon." Standing by one of the aircraft, Group Capt. Iveson, the force commander (left), talks to crew members prior to the midnight take-off from Nairobi.

Fl. Lt. Elmey (navigator, left), Flg. Off. Humphries (co-pilot, centre) and the captain, Fl. Lt. Conway, fit the jet pipe blanking covers. The tail compartment stands open awaiting the loading of another braking parachute.

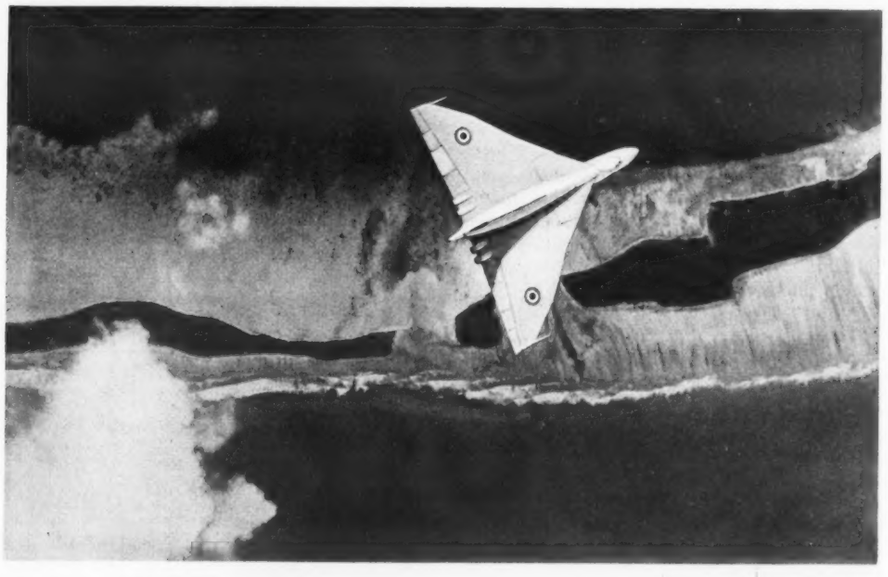
hearsal. A steady stream of question and answer exchanged between all five crew members in turn illustrated the complexity of these aircraft and the necessity for the utmost cohesion amongst the crew to ensure both flight safety and successful operations. The check list progressed with "voices off" from the crew chief, who was reporting control surface movement from outside the aircraft on an extension intercom. Finally the engines were started, the crew chief came aboard, locked the exit hatch and reported the aircraft cleared for flight. Sitting in the semi-dark with no outside view I was only able to follow events through the intercom until the captain received take-off clearance from the control tower. A moment later came the steadily increasing engine noise, followed by a phenomenal acceleration as the aircraft gathered speed down the runway. A change of attitude as the nose came up, a reduction in vibration, and the aircraft was airborne. A steady climb through the heavy overcast sky to the clear air at 45,000 feet steering a course at the same time for a turning point over the North Sea. The target for the simulated bombing exercise was to be an aircraft hangar on a Midlands airfield. Arriving at the turning point, course was then laid for the target, and the bomb aimer commenced to direct the aircraft to the unseen hangar hidden below the heavy clouds. This was done by map reading from the radar display and feeding the checkpoint coordinates into the navigation computer, whereupon this equipment proceeded to digest the details of the aircraft's progress and commenced indicating the distance and time remaining to go to the target. As we approached the still invisible target, RT contact was made with the ground radar unit which would plot our bombing run and calculate the point of impact of the bomb. The bomb aimer commenced his reports of time and distance to go and gave final corrections to the bombing run. At last came "Ten seconds to go" and then the countdown "Five, Four, Three . . . Bomb gone!"

After completing the run, which took the aircraft over South Wales, course was set for the French coast and the journey proper. Some minutes later the ground radar unit transmitted a string of code figures which represented the calculated point of impact of the bomb. Allowing a few moments pause for deciphering, the captain then asked the bomb aimer for the result. A voice of studied calm replied—"Direct Hit." Thus my first introduction to the bombing accuracy of the V force.

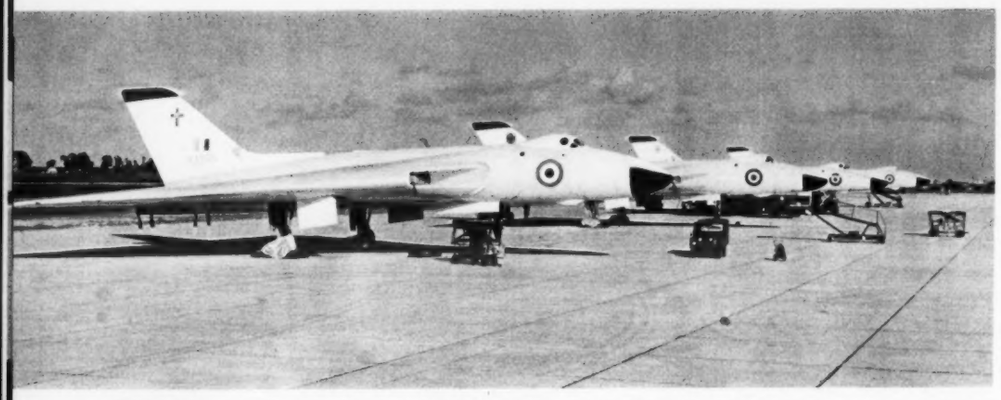
There is little to report of the flight across France and the Mediterranean. Thick cloud obscured the ground for the greater part of the route to the southern coast of France. Reaching the Mediterranean the clouds dispersed, and the sea appeared motionless and glittering in the sun. For a passenger, visibility from the *Vulcan* is somewhat limited, and I was compelled to divide my time between peering over the pilots' shoulders on the flight deck through the frost-coated windscreen and lying prone at the bomb aimer's window in the belly of the aircraft.

At this point in the flight we encountered a grave setback. Flight rations were distributed and coffee served from a vacuum flask. On

A good landfall. In the early morning light a *Vulcan* passes over the Addu atoll prior to landing at Gan.



Air refuelling extends the range and endurance of the *Vulcan*. The pattern of condensation trails shows the meeting point between the *Vulcan* and the tanker *Valiant*.



RAF Station, Gan. A coral "aircraft carrier" in the middle of the Indian Ocean, with the four new arrivals parked for the night.

tasting my coffee I found it to contain a liberal ration of salt instead of sugar. My first reaction was that perhaps this was an intentional arrangement by the catering staff to protect us from heat exhaustion in tropic climates. These ideas were rapidly dispelled a few moments later when a flood of protests over the intercom from all the crew members left me in no doubt that if the gesture had been intentional it was entirely unappreciated by all hands. The range of modern RT equipment came to our aid however, and the captain was able to pass his compliments back to base while his opinions were still fresh and unclouded. It was then that I appreciated the existence of the gallon water jar that was a particular idiosyncrasy of this crew. Stowed on the exit hatch it remained ice-cold throughout the flight, and its refilling at succeeding stops became one of the standard preflight checks.

Leaving the French coast near Nice the route followed the length of the Italian coastline. Then directly over Malta, barren and rocky, baking in the sun, with a scattered pattern of bomb craters still visible. Finally the brown and featureless expanse of the African coast, partly hidden by the haze. At last the runway of El Adem, scarcely noticeable in the expanse of desert. Prior to landing the crew carried out a series of practice landings, four overshoots and two rollers before a final approach and landing followed by the jerk of the tail braking parachute.

A few minutes in excess of five hours' flying time had been sufficient for a bombing exercise in England, a flight from England to North Africa and a series of practice landings on arrival. It should also be added that the practice landings were partly dictated by the necessity to burn off sufficient fuel to get down to our maximum landing weight!

On arrival at the dispersal, the crew then turned to the next stage of the day's duties. The aircraft was refuelled and each crew member proceeded to make an inspection of the aircraft systems which came within his province. The blanking plugs were fitted in the engine intakes and jet pipes, the tail parachute retrieved and stowed for transport, and a new parachute fitted in the tail compartment. The aircraft was then certified serviceable and ready for flight for the next stage of the journey.

The second day

The next stage of the journey was to be El Adem–Nairobi (Embakasi Airport). The departure was a repetition of the previous day, the long check lists, the rising engine noise and then the fierce surge of acceleration and the effortless climb to our cruising altitude of 45,000 feet. The first part of the route lies over featureless desert—hundreds of miles of sand and rocky outcrops with an occasional faintly discernible trail threading its way through the wastes. From the navigational point of view this part of the trip offers the fewest facilities. There is little detail to be picked up on the ground mapping radar. Ground beacons are virtually non-existent, and visual map-reading difficult. Despite these complications the trip was uneventful. Perhaps the most awe-inspiring sight during the flight was a tropical cumulus lying across our track. At 45,000 feet we just passed over the top of it while on our starboard side a further anvil towered several thousands of feet above the aircraft. One other incident did arise during the flight which occasioned a certain amount of brain racking. Several hundred miles south of El Adem we received a fragmentary RT transmission from the airfield control. Piecing together the few words which were understandable we gathered that a runway lamp had been found completely demolished on the El Adem runway, and the controller was advising caution during landing at Nairobi in case any undercarriage or tyre damage had occurred to one of the four *Vulcans*. No doubt the same discussion took place in all four aircraft on receipt of the message, each captain being certain that one of the other three aircraft was the offender. As a precautionary measure on arrival at Nairobi, each aircraft did a low fly-past with undercarriage extended to enable the control personnel to check the condition or at least the presence of all eighteen wheels on each aircraft. This exercise at least gave me an opportunity to see the docility with which this big delta handles at low speeds, and the immediate throttle response of the four *Olympus* engines. All aircraft landed without incident and were found to be undamaged. The mystery remained unsolved — who wrecked the runway lamp at El Adem?

Embakasi Airport is a newly built modern airport lying near the original airport of Eastleigh. With its 10,000-foot concrete runway and open approaches it offered no landing problems for the four aircraft, although its 5,400 ft altitude above sea level reduces the runway length to an effective 8,000 feet. The altitude of Nairobi at least offered a pleasant climatic change from the desert heat and dust of El Adem.

After landing, the same servicing routine was completed. Unaided the crew refuelled and inspected the aircraft, fitted a new tail parachute and completed the preparations for the next flight.

Owing to a number of factors it is both misleading and uninformative to give the flying times for each stage of the flight. Landing practice and circuit delays inflate the exact figure, but the journey El Adem–Nairobi, including overshoot landings, was completed within four and a half hours.

The third day

The fact that this was a training exercise and not a record-breaking flight has already been mentioned. For that reason the daily times of take-off were adjusted to meet the training requirements.

For the first two sectors of the route the take-offs had been 0900 hours at Waddington and 0800 hours at El Adem. After arrival at Nairobi during the mid-afternoon local time on the second day, the next take-off was scheduled for midnight the following day. This one-day pause came at an opportune moment

Tin roofs, palms and monsoon drains, and for many airmen stationed in the Far East the staging point on their route to England.

Equatorial Post Office. A palm-thatched hut on a coral island but with the familiar red letter box.

for my crew because after landing at Embakasi Flg. Off. Hall, the Air Electronics Officer, reported a generator failure. As a spare generator was carried in the pannier of stores in the bomb bay, the crew were able to change the faulty unit themselves on the following morning and have the aircraft serviceable for the night take-off.

The reasons for the night flight to Gan were twofold. Apart from the opportunity for night flying and astro navigation during the trip, it would also position the aircraft at Gan at first light before the glare became too intense from the coral and the concrete runway.

My recollections of this night flight are varied. The crew chief stretched out in a futile attempt to sleep on a pile of hard and unyielding survival packs in the tunnel under the flight deck. Myself in the almost complete darkness of the rear compartment conducting a complicated routine of place changing with Flg. Off. Doyle as he moved from one side of the aircraft to the other to take astroshots through the port and starboard sextants. The problem of changing intercom plugs each time we changed places, the chill of the −45°C outside temperature seeping through the floor of the aircraft where one's feet were below the level of the hot air ports, and the unavailing efforts to defrost one of the sextant periscopes which reacted unfavourably to being projected in the icy airstream. This last complication led to a modification of the place changing game. Instead of merely climbing over one another and finding and reconnecting our intercom plugs in alternate sockets, all in a space barely three feet square and already encumbered by the flight deck ladder, we added an extra hazard by changing the serviceable sextant from side to side of the aircraft at each move as well. I must repeat my congratulations to Flg. Off. Doyle—after nearly two hours of this exercise he was still on speaking terms with me, albeit in somewhat frank terms.

At last a trace of red appeared on the horizon, and dawn broke with startling speed. The radio compass settled onto a steady bearing as the transmission from the Gan beacon increased in power, and soon the Addu atoll appeared ahead. The newly constructed airfield occupies the whole of one small island in the U-shaped chain which forms the atoll. Forming part of the Maldive group, the island has steadily increased in political and strategic importance as a staging post on the RAF routes to the Far East. An idea of its size can be gained from the fact that a trip round the island by car takes ten minutes, and the single runway extends across the island from beach to beach. From the navigation standpoint, finding the island poses a neat little problem, particularly bearing in mind that the nearest alternate landing ground is in Ceylon, a thousand miles away.

The four aircraft landed safely, and the routine of servicing and refuelling commenced. As the last lap of the journey was to be completed the following day, the crews then stood down and tried to catch up with a night's loss of sleep. Owing to the heat and humidity this was no easy matter, and the majority spent the greater part of the day swimming in the tepid waters of the coral lagoon.

Malaya bound. In the light of the rising sun an aircraft of the force taxies out and takes off from Gan en route for Butterworth.

The fourth day

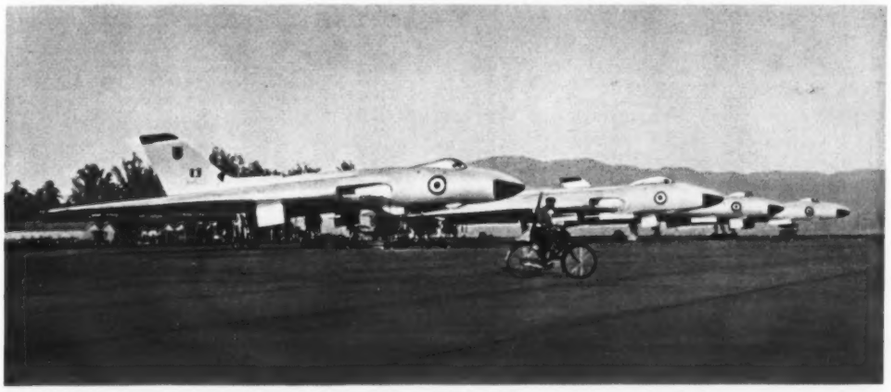
The take-off for the final stage—Gan to Butterworth, Malaya—was scheduled for first light the following morning. This was done to enable the aircraft to arrive in Butterworth before the midday build-up of cumulus and thunderstorm activity. The route selected ran from Gan to a turning point off the northernmost tip of Sumatra and then down the strait separating Sumatra from Malaya. A last-minute signal giving clearance for the aircraft to overfly Sumatra enabled the route to be changed, and the aircraft set course direct. As the coast of Sumatra came within radar range, and checkpoints were identified, the navigator passed the final course changes to the captain for the last stage of the journey. Nearing Butterworth, the sight of condensation trails in the sky indicated that the *Avon Sabre*-equipped RAAF squadrons based there had seized the opportunity of using the *Vulcans* for an interception exercise. One *Sabre* picking our aircraft as his target positioned himself ideally on the port side for a quarter attack and commenced to turn in towards us. A movement of the *Vulcan's* throttles, and the attacker was reported to be ten miles astern and losing ground rapidly. We were through the defences. Minutes later the outline of Penang island appeared, and the two runways of Butterworth came into view. A let-down to 20,000 feet and positioning for the final let-down, throttles closed, air brakes extended, the altimeter rapidly unwound. A change in slipstream noise as the undercarriage was extended and then the rumble of the wheels on the runway, followed by the jerk as the tail parachute streamed. For me at least the journey was over, and my apprenticeship completed.

Retrospect

Looking back at the host of impressions which I accumulated during the trip, it requires careful selection to choose the most outstanding. Of the *Vulcan* itself, one can only say—truly a superb aircraft. With its delta planform, power, and manoeuvrability at altitude it gives more an impression of fighter performance than a bomber. Relatively viceless and yet quick to exert a penalty for inattention, its performance continued to astonish me.

More important than the aircraft, however, are the crews who man them. To be a member of the V force is no small achievement in itself and indicates an airman of considerable experience. Furthermore it requires men of a particular temperament and initiative. Entry into the force, however, is only the first step in the process. A system of classification exists within the Squadrons which applies both to the crews and to the individuals themselves. The four categories—unclassified on first joining a Squadron, followed by combat, select and select star, represent stages in an infinitely difficult progress. My own crew carried a select star rating, and many times during the trip I saw evidence of the amount of continuous work and individual self-

Journey's end. Under the eye of an armed and mounted guard the force stands on the tarmac of the RAAF Station Butterworth, Malaya.



A *Vulcan* demonstrates its take-off performance.

discipline that was required to maintain this hard-earned classification.

Apart from their constant pre-occupation with training and performance I was also able to gain some insight into their daily routine at their home base, Waddington. In an age when disputes over working hours, wages and leisure time are reported almost daily in the Press, it is a sobering thought to consider the lives of the V force crews. They live under conditions of almost continuous standby and subject to practice alerts at all times, and I was struck by their professional pride in the speed at which they could be called from their homes or quarters and get their aircraft airborne. It is a clear indication of their realistic attitude that they accept this lack of freedom of movement for the privilege of belonging to the force.

To describe them at work in the air it is easy to talk in terms of teamwork and co-operation. What did strike me forcibly was the evidence of every man doing much more than was necessary for the actual navigation of the aircraft. Flg. Off. Doyle, the bomb aimer, continually at the radar scope to assist in the navigation or to make dummy bombing runs. Flt. Lt. Elmey, the navigator, checking and cross-checking his calculations to produce ETA's accurate to within seconds. Flg. Off. Hall, the Air Electronics Officer, endeavouring to make the greatest number of contacts on the HF radio at the longest possible range. In future I shall always regard the AEO as the loneliest member of the crew. Transmitting or listening to the HF radio, he is rarely switched to the normal aircraft intercom and hears little of what is being said on board. As for the captain and co-pilot, their work is chiefly that of monitoring the aircraft performance. Flying at high altitude with the autopilot engaged may appear a fairly easy task. In a jet aircraft travelling ten miles a minute it is not sufficient merely to monitor the aircraft's current performance. The necessity for thinking continually ahead of the aircraft is perhaps the hardest part of jet flying. Without this forward thinking an incident develops into an emergency and then into a catastrophe within seconds.

During the flight I was often struck by the long periods during which no remarks passed over the intercom. The three figures bent over the desk and the voiceless quiet gave one the impression of an examination in progress. Perhaps this economy of words was due in some measure to the captain. A mask microphone inadvertently left switched on and transmitting the aircraft noise to all the crew members' headsets would be swiftly greeted with a brief "Speak up or switch off" from the flight deck. A small point in itself but indicative of the need for continuous concentration on the job in hand and the removal of any distractions.

"Mad dogs and Englishmen—." The difficulties of acclimatization for the crews are emphasized by this local Malayan resident who finds the day-time temperatures excessive.

Apart from the aircrew side of their duties, the crew also carried out the maintenance and servicing of the aircraft along the route. This in itself adds greatly to the mobility of the V force. Each aircraft carried in the bomb bay a large pannier containing an assortment of spares and servicing equipment. The selection of this equipment was the responsibility of the technical staff at Waddington, and one result of these long range exercises is to give valuable information on requirements for force mobility. The fact that all four aircraft arrived on schedule in Butterworth, having carried out wheel changes and a generator change en route, points to the technical staff having made the right guesses and having not overlooked any vital item for the aircraft servicing. As all this technical equipment was distributed among the four aircraft, and our own pannier contained a large quantity of small stores, we were the aerial storekeepers for the force.

The prospect of lowering the pannier and searching for the required part in tropic heat caused us to exhibit a somewhat miserly attitude towards the other crews over the issue of spares. It is a tribute to the aircraft and its mass of equipment that the troubles encountered were minor and within our scope. As for the *Olympus* engine the same holds true. All sixteen completed the trip without a single snag, and the only attention they demanded was the supply of formidable quantities of fuel. It is possibly the handling qualities of this engine which adds so much to the docility of the *Vulcan*. The immediate throttle response and surge of acceleration simplify both manoeuvres and landing. It is a remarkable experience to stand on the ladder overlooking the pilot's shoulders during a practice overshoot. Without a firm grip on the backs of the two seats, there is a strong possibility of being thrown from the ladder as the aircraft accelerates and climbs away.

This flexibility and rapid response to throttle adjustment contributes enormously to the ease of aircraft control in all conditions of flight. In consequence it was easy to appreciate the crew's oft-spoken praise for the aircraft's capabilities, and it is interesting to consider how much this confidence adds to the crew's efficiency.

During the journey no records were broken for speed, distance or endurance. On the other hand the V force amply demonstrated its mobility and self-sufficiency, and the efficiency of its aircraft and crews, and I was given ample opportunity to see its capabilities in terms of modern weapons. Changes and no doubt even higher standards of performance lie ahead. The *Vulcan* already exists as a carrier of the *Blue Steel* stand-off bomb, and the techniques of this type of bombing are well known to the force. The future capabilities of the V force when equipped with later Marks of aircraft and with the *Sky Bolt* ballistic missile leave no doubt as to its potential power in war or as a force for peace. ⟷

Curtain Raiser to Farnborough

The Ideas, the Men and the Workshops of the British Aircraft Industry

By Dr. H. Rieck, Interavia, Geneva

When, shortly after this issue appears in print, the curtain goes up on the 21st SBAC Flying Display and Exhibition, and some two score or more civil and military aircraft of the most varied types make their bow on the concrete stage of RAE's Farnborough airfield, they can do little more than illustrate the lines along which the British aircraft industry has been working during the past five or ten years. It is obviously not to today's operational aircraft that one must look for signs of what the next decade will bring, or for hints of future development trends.

Farnborough habitués have therefore made it a practice to divide their limited time roughly equally between the static show, the flying display and the exhibition tents. Making their way patiently from stand to stand in these tents, they keep their eyes open for new aircraft models and engine mockups, even for insignificant-seeming drawings, which might give a pointer towards the future. To help in this search, and to be able to interpret and extrapolate the current state of British aeronautical engineering, *Interavia* each year makes a round of visits to the most important manufacturers' plants, a month or two before the SBAC display. These visits give London Editor Derek H. Wood and one of his Geneva colleagues an opportunity for talks with leading personalities in the industry. This year it was the turn of Geneva's Managing Editor.

New wine in old casks

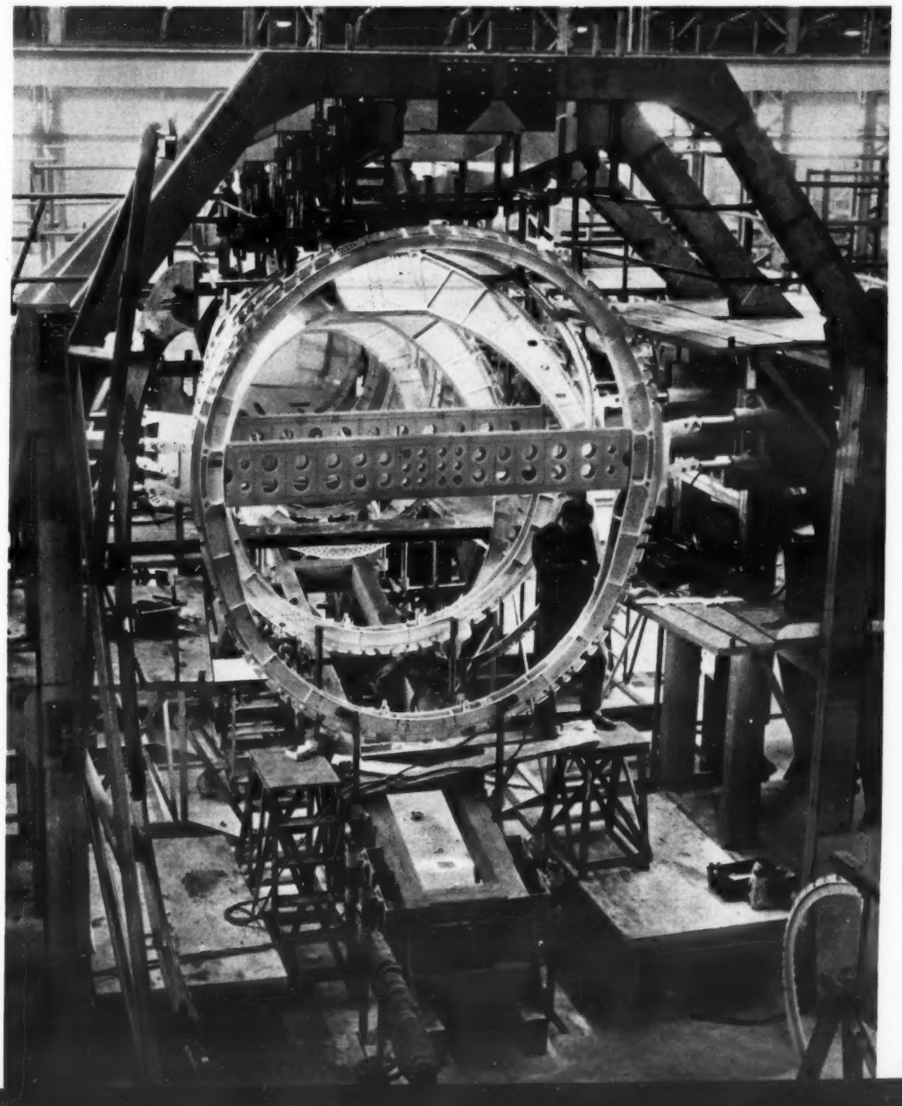
In this year of grace 1960, when three of the best-known British aircraft companies have their Golden Jubilees behind them (A. V. Roe, Handley Page and Short Bros.), and two more (Blackburn and de Havilland) are preparing to celebrate the 50th anniversary of their first flights[1], it is both stimulating and encouraging to examine the many new, and in some cases pioneering, ideas which will set their mark on tomorrow's aircraft. After years of careful testing in the island kingdom's wind tunnels, test beds and laboratories, most of them have now taken on tangible shape; i.e., the aircraft which incorporate these ideas are already under construction. Some of the more important of these lines of development are listed below.

[1] Sir Geoffrey de Havilland successfully flew his first biplane (with 45 h.p. engine) in 1910, and Robert Blackburn took off in the same year from the sands at Filey, Yorkshire.

• **Rear-mounted bypass jets . . . :** Whether designed for two engines (Hunting 107 and Avro 761/71), three (DH.121) or four (VC.10 and Super VC.10), no "second generation" British jet airliner will have its powerplant buried in the wings or, for that matter, suspended in pods beneath them. In each and every case, engines will be mounted at the rear of the fuselage. The successful example of Sud-Aviation's *Caravelle* has been emulated in Britain, and the British have no hesitation in paying tribute to this French pioneering achievement.

Secondly—and here lies Britain's own particular contribution to this solution—all the new passenger aircraft will have fuel-saving *bypass jets:* Bristol Siddeley BS.75 in the Hunting 107, Rolls-Royce RB.163 in the DH.121, and Rolls-Royce *Conway RCo.42* in the Vickers VC.10 and Super VC.10. It will of course be recalled that the basic principle of the bypass jet was to be found in Whittle's 1936 patents and was first put into practice, in the form of an aft fan, in the 1943 Metropolitan-Vickers F. 2 axial flow jet turbine. But

Four Rolls-Royce *Conway RCo. 42* bypass engines at the rear of the Vickers VC. 10: picture shows the two transverse engine beams and the fuselage frames which carry the fin attachments. All frames are of machined integral construction in high-strength aluminium alloy, while the engine beams are of steel.



it was left to the Rolls-Royce *Conway RCo.12* (with 7-stage low pressure compressor for both primary and secondary flow) to gain a firm foothold in civil aviation, being fitted in the Boeing 707s and Douglas DC-8s for Air India, Alitalia, BOAC, CPA, Lufthansa, TCA and Varig. The bypass engine is now in a fair way to ousting both turboprop and straight jet from the passenger-carrying transport business. The reasons are the following.

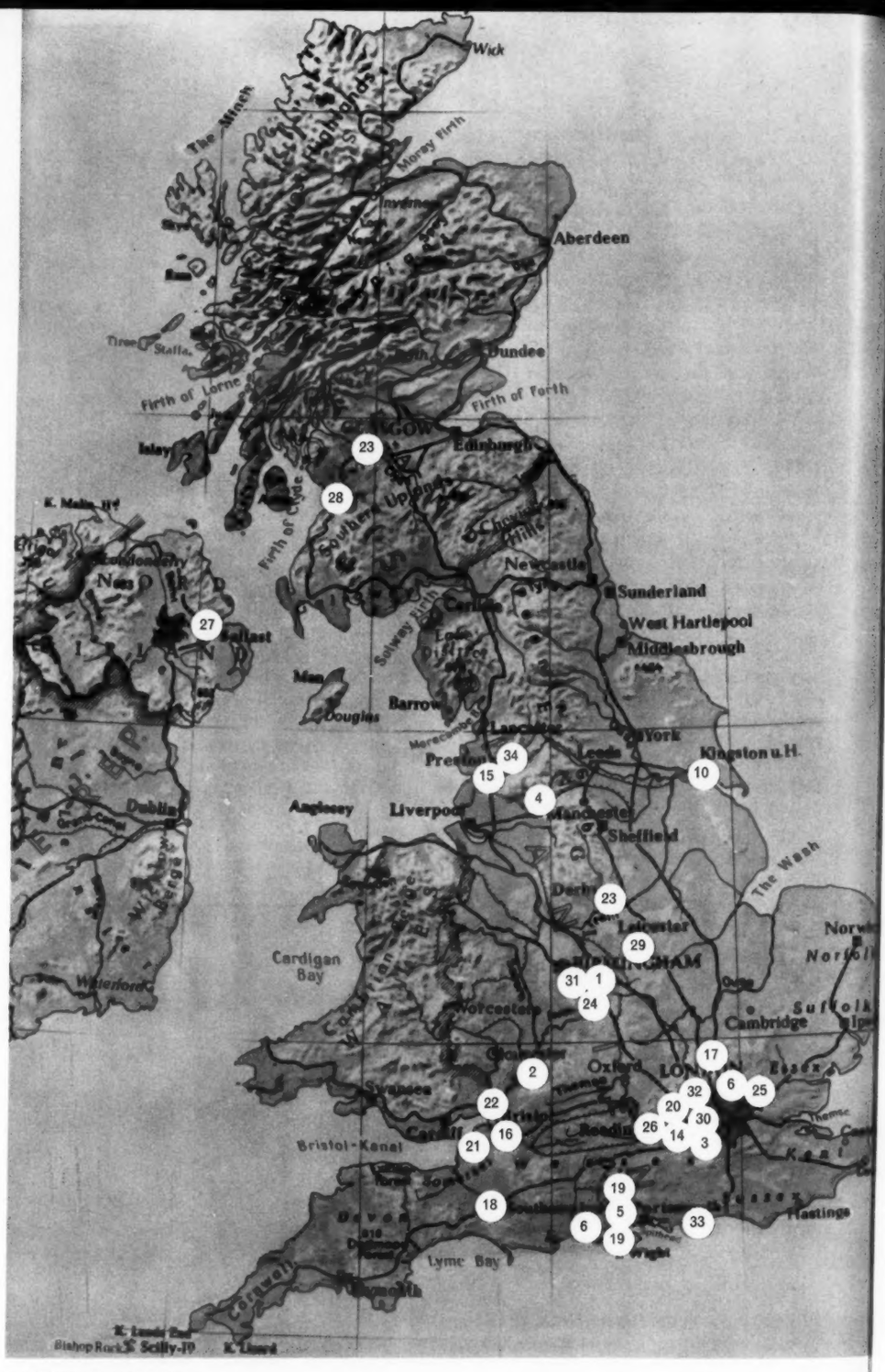
Within the next ten years at the most, propeller aircraft—even when the propellers are driven by gas turbines—will be regarded by the travelling public as hopelessly antiquated. What is more, the very moderate fuel consumption of the bypass jet makes for economical operation even over short stages, and the airlines must meet public demand unless there are very compelling reasons for not doing so. The turboprop will thus find itself relegated, in the foreseeable future, to business aircraft and freighters, while the pure jet will be reserved for the military services and possibly the future supersonic airliner. All the designers to whom we spoke on this year's tour were agreed on this point.

● **. . . and their bypass ratio:** My first question to the engine experts concerned their views on the most important parameter in any bypass engine, namely the bypass ratio—or ratio of cold secondary air flow to hot primary air flow. *Mr. A. C. Lovesey,* Rolls-Royce Chief Engineer—Aircraft Engines, replied that this ratio must lie between 0.7 and 1.2[2], if the optimum fuel consumption in cruise is to be obtained. It is true that the specific fuel consumption would decrease still further with increasing bypass ratio; but then the external diameter of the engine would have to be enlarged, so that the extra drag arising in cruise flight would cancel out the saving gained in theory. Added to this is the fact that every modern jet engine must have a thrust reversal device, and this would become impossibly heavy for a very large engine diameter. For these reasons the *Conway RCo.42* (for the VC.10) and the RB.141 (for the *Caravelle VIII*) have a bypass ratio of 0.7, and the RB.163 (for the DH.121) a ratio of 1.0; fuel consumption, static, roughly 0.5 lb/lb/h; in cruise below 0.8 lb/lb/h.

The second decisive advantage of the bypass engine—its reduced noise production—was commented on by *Dr. S. G. Hooker,* Technical Director of Bristol Siddeley: "Take a bypass ratio of One as basis. To obtain the same thrust as for a pure jet, you must reduce twice the air mass of the pure jet to half the latter's mean exhaust velocity. We have found that the noise *behind* the jet pipe grows as the air mass flow and as the seventh power of the exhaust velocity. A bypass engine with a bypass ratio of One therefore, in theory, produces only one sixty-fourth as much noise as a pure jet of equivalent power. On the other hand the noise *in front of* the engine, the so-called approach noise, increases considerably with increasing bypass ratio, so that here too one must seek the golden mean."

● **Triplication:** "All good things come in threes"... this is the principle upon which

[2] A bypass ratio of One means that the same number of pounds of air pass through the secondary channel as through the combustion chamber.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Aberdeen
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Firth of Forth
Edinburgh
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Sunderland
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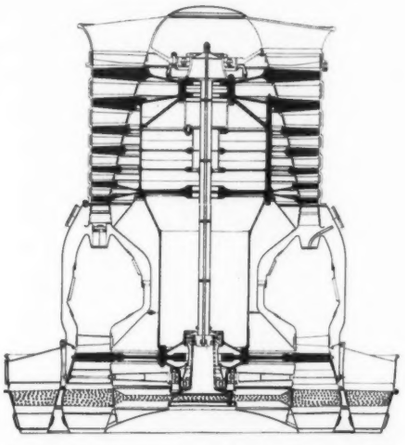
Middlesbrough
Newcastle
Carlisle
Barrow
Douglas
Lancaster
York
Leeds
Kingston u.H.
Preston
Liverpool
Manchester
Sheffield
Anglesey
Dublin
Cardigan Bay
Waterford
Derby
Leicester
Norwich
Norfolk
Worcester
Cambridge
Suffolk
Oxford
Essex
Bristol
Cardiff
Bristol Channel
Swansea
Reading
Hastings
Devon
Lyme Bay
Wight
Plymouth
Cornwall
Bishop Rock
Scilly-Is
Lizard
The Wash
Solway Firth
Firth of Lorne
Three Sisters
Stafa
Mull
Islay
Arran
Inverness
Moray Firth
The Minch
Highlands
Grand Canal
Shannon
Irish Sea
English Channel
Celtic Sea
Bristol Channel
Lyme Bay
Cardigan Bay
Wash
Thames
Kent
Sussex
Hampshire
Dorset
Devon
Cornwall
Norfolk
Suffolk
Essex
Lancashire
Yorkshire
Cheshire
Wales
Scotland
Ireland
Northern Ireland
Isle of Man
Isle of Wight
Scilly Isles
Lizard Point
Land's End
Bishop Rock
Dublin
Belfast
Londonderry
Glasgow
Edinburgh
Aberdeen
Dundee
Wick
Inverness
Ayr
Islay
Arran
Mull
Three Sisters
Stafa
Firth of Lorne
Firth of Clyde
Firth of Forth

one of the new airliners—and some of the research and military aircraft—are based. Not two hydraulic circuits, but three, in parallel throughout, from the engine-driven pumps via the accumulators to the jacks for control surfaces and flap actuators. The electrical systems are also triplicated, and in the case of the DH.121 the triplication principle even extends to the engines; it is known as "triplexing."

• **Votes for autopilots:** It was new to me, however, that autopilots must now be fitted in triplicate. This marks a radical changeover from "dictatorship" (seul maître à bord après Dieu) to the "democracy" which is necessary to ensure fully automatic blind landing by the Autoflare system (in the vertical plane only) and later by the Autoland system (vertical plane plus base line). *Peter F. Hall*, a New Zealander by birth, wartime RAF pilot and today head of de Havilland Aircraft's Sales Engineering Group, gave the necessary explanation: "Provision is already made in all recent airliners for the ILS system to be coupled to the autopilot, but it is seldom used... as a pastime in good weather, and down to a cloud base of 200 ft in bad. Ignoring the often insufficient accuracy of the localizer and the glide path transmitter, the error margin of the autopilot is primarily responsible for this state of affairs. Admittedly the autopilot is automatically switched off when certain error limits are exceeded, i.e., the human pilot must then continue the flight manually. But the error tolerances are so great and the switching delays so considerable that the existing weather minima cannot be reduced. One could, of course, install two independent autopilots and leave them to work jointly so long as they agree in their control signals. But if one autopilot says 'do' and the other says 'don't' an error signal is formed which switches off both autopilots. This already provides a certain improvement in sensitivity, but it is still impossible to tell which autopilot was right and which was wrong. We should therefore take three autopilots and a common monitor which in the case of a 'two-to-one' argument merely switches off the minority... and the problem is solved. Cloud bases of zero feet and visibilities down to 50 yards will then no longer be an impediment to safe landing operations. Below these visibility limits there is no point in making a landing, as the road traffic away from the airport would also be at a standstill." And Mr. Hall added: "Not so long ago several gentlemen from Smiths had an appointment for talks with us here. They set out in good time by car, but ran into thick fog en route. So they turned back, got into their highly instrumented *Dove* and flew up to Hatfield in time for the meeting. I must add, of course, that the Hatfield ILS is very accurate and reliable."

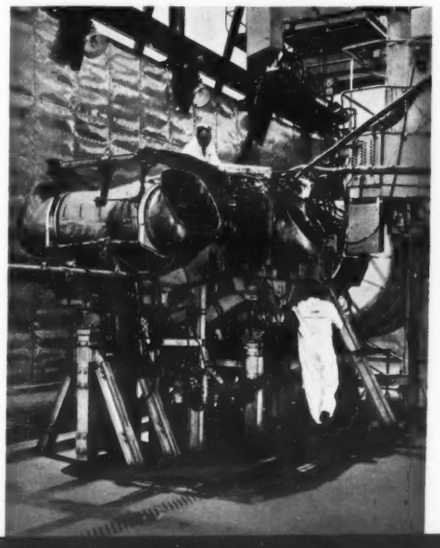
• **Supersonic airliners or "the problem of the third generation":** Opinions in Britain on this subject are still divided. On the one hand, all realize that any such aircraft will cost some £150 million to develop to the operational stage and that the market for a supersonic aircraft can only be small, in view of its tremendous productivity, its higher operating costs and its specific design for a few selected routes. On the other hand, nobody wants to abdicate without a struggle

The English Electric P.1 *Lightning* (two Rolls-Royce *Avons*) is now in squadron service. It can be armed with four 30-mm Aden cannon, two de Havilland *Firestreak* infra-red air-to-air missiles or 48 unguided 2-inch rockets. The latter (picture) are carried in a plastic container made of Microcell glass fibre, which is lowered from the fuselage just before firing.



Lightweight lift engines have short squat combustion chambers, a moderate number of stages in the compressor and a single-stage turbine, and require only two main bearings. If a free-running aft fan is added, the thrust can be still further improved (*drawing by Bristol Siddeley*).

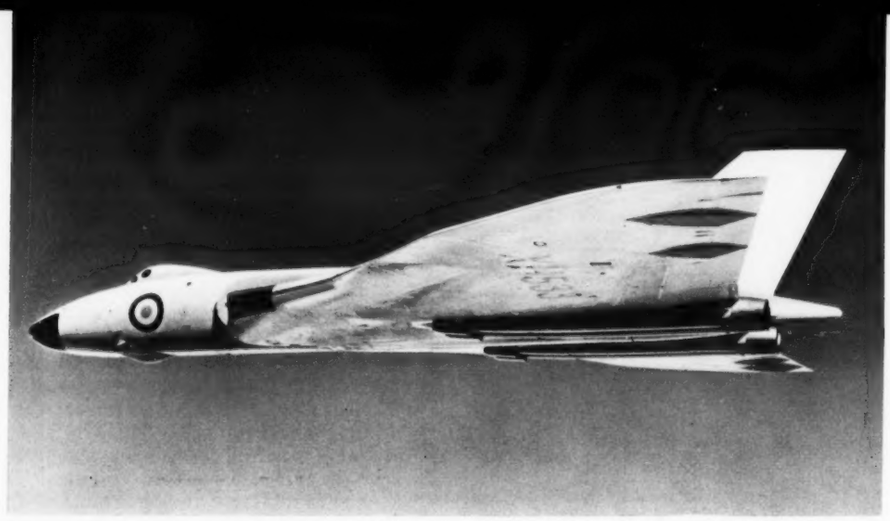
Bristol Siddeley BS.53 lift-plus-thrust engine (powerplant in the P.1127) on the test bed, shown here in the "lift" position, with nozzles turned upwards. This lightweight ducted fan engine has been under test for the past twelve months. It is of two-spool design, with low-pressure compressor (fan) and high-pressure compressor rotating in opposite directions.



from a position of technical equality with the United States and the Soviet Union, at any rate not in air transport. It is, of course, known that the Mach 3 aircraft, optimized for maximum operating economy[3], must from the outset be constructed of stainless steel—or steel sandwich—but design and manufacturing experience in these materials is not yet adequate. However, an aircraft for a cruise Mach number of around 2.2 can be of the traditional light metal integral construction for which all of Britain's leading manufacturers are well equipped. It follows that Mach 3 aircraft of steel will probably not be available before 1975, while a Mach 2.2 aircraft of light metal could be flying by around 1970. Even in ten years, of course, the big majority of Atlantic and other long-range routes will doubtless still be operated by subsonic jets of the first or second generation. But perhaps by then there will be a sufficient number of hard-pressed businessmen willing to pay appropriately substantial extra fares for the time saving offered by supersonic travel. *Sir George Edwards,* Executive Director, Aircraft, of British Aircraft Corporation and Managing Director of Vickers-Armstrongs (Aircraft) Ltd., remarked: "Actually there have been several occasions when I should have gone to Australia, but it would have taken me too long by subsonic aircraft. I therefore had to cancel the trip, for lack of time." Will a third generation of jet airliners for a cruising Mach number of around 2.2 be created before the fourth generation of Mach 3+ aircraft (and probably the last for at least some time to come) arrives on the scene? Both Hawker Siddeley and BAC are working on such a model. The BAC design would reportedly have a thin delta wing with roughly 30 degrees leading edge sweep and be powered by six buried engines in the 14-ton thrust class (developed Bristol Siddeley *Olympus* or new Rolls-Royce RB. 167). It is further rumoured that the aircraft would have a take-off weight of around 350,000 lb, carry up to 124 passengers and cover block distances of up to 3,000 nautical miles. One newspaper even reports that *Dr. A. E. Russell,* Chief Engineer at Bristol Aircraft and designer of the *Britannia,* is in charge of the preliminary studies. Sir George Edwards, who would be ultimately responsible for the project, was very reserved on this subject, and all we could gather from him was that BAC does have a supersonic design—along with several subsonic projects—on the drawing board. In all probability, it would be an aircraft for conventional take-off.

A radically different design philosophy is followed by Rolls-Royce's advance planning and long term research group headed by *Air Chief Marshal Sir Ralph Cochrane;* this group is solidly behind the ideas of Dr. A. A. Griffith, one of the group's leading scientists. Sir Ralph explained—and demonstrated with a number of sketches—that it would be possible, for example, to construct a sharply swept delta-wing aircraft for 74 passengers and a gross weight of less than 40 tons and have it take off and land vertically with the aid of a battery of 24 or more VTOL engines, e.g., an advanced model of the RB.145. Cruising

[3] See "The Case for the Supersonic Transport" by Hall L. Hibbard and Robert A. Bailey, in *Interavia* No. 10, 1959, p. 1234 etc.



Successor to the B.1, the improved *Vulcan B.2* with four advanced *Olympus* engines (picture) isi n production at A. V. Roe. It will carry long-range Avro *Blue Steel* air-to-surface weapons (one per aircraft), and later Douglas *Sky Bolt* missiles (two per aircraft).

Mach number would be 2.2, and propulsion would be provided by eight main engines housed in the fins. Control would be by means of a group of three lightweight engines (RB. 145 or later category) in the nose and two groups of four similar engines in the rear. With a power/weight ratio of 16 : 1 and allowing an additional 50 percent for mounting, fuel system and automatic compensation device for failures, the dead weight during cruise would be less than 10 percent of the take-off weight, which would to a large extent be made good by the absence of an undercarriage. Take-off and landing would take place fully automatically, on a concrete platform covered by a steel grid, and would be controlled by signals from four directional beacons. Rolls-Royce has built a special test bed, known as the "Greasy Pole," to test the touchdown system; a group of VTOL engines slides down the pole under their own thrust control. The aircraft model now under study is designed only for short/medium stages and could thus operate supersonically only above the sea—where the population would not be disturbed. A considerably larger design is being worked out for trans-Atlantic services[4]. Rolls-Royce will probably be showing sketches of several variants of the Griffith project on its stand at Farnborough.

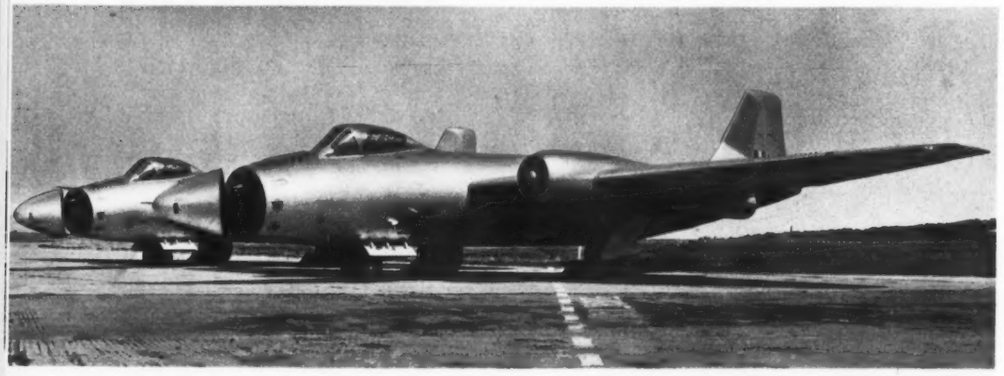
[4] See the older Griffith design shown in "VTOL or STOL?" in *Interavia* No. 1, 1958, p. 60.

• **Military VTOL equipment:** In view of the spectacular successes which Short Brothers & Harland has achieved with the SC.1 research aircraft, it is not surprising that the company should be thinking of an advanced model of this design (one cruise engine and separate lift engines), to attain supersonic speeds at altitude.[5] At the same time it is fully realized that aircraft of the SC.1 (or Griffith) formula will always be dependent on prepared platforms of steel or concrete and cannot take off or land in just any field or forest clearing. The thick clouds of dust raised from the naked earth by the jet efflux would completely obscure the pilot's vision and clog the engines. Some form of ground organization, however rudimentary, is thus still required: sections of roads, or metal platforms laid out for the purpose on *terra firma*... or structurally stiffened decks in the case, for example, of merchant ships equipped for autonomous anti-submarine defence.

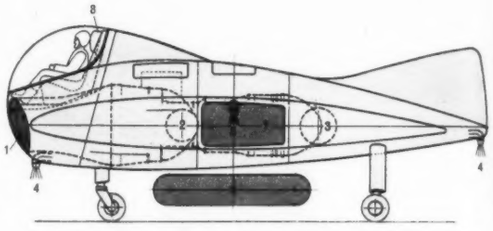
On the other side, *Sir Sidney Camm*, Director and Chief Engineer at Hawker Aircraft Ltd., uses very convincing arguments in support of the view that a military VTOL aircraft must be able to manoeuvre on the ground and, if need be, take off from unprepared terrain, in the latter case using a short take-off run to avoid raising too much dust. His "baby," the Hawker

[5] See David Keith-Lucas, "Jet Lift for Supersonics" in *Interavia* No. 5, 1960, p. 565 etc.; also "The Short SC.1 VTOL Research Aircraft" in *Interavia* No. 8, 1960, p. 982.

The English Electric *Canberra* is still in quantity production at Short Brothers & Harland. The version illustrated is the PR.9 high-altitude reconnaissance model, with a hinged nose designed by Shorts.



P.1127, will probably have flown by the time these lines appear in print, as design and prototype construction have taken less time than originally calculated. Although basically a research aircraft, the P.1127 could probably fit into NATO's arsenal of strike aircraft even in its present form, since it can carry efficient air-to-surface weapons for use against tanks and troop concentrations. It is known that the P.1127 is powered by a single Bristol Siddeley BS.53 ducted fan engine, with four rotating nozzles—apparently swivelling very rapidly through 90 degrees—and deflection cascades. According to a recent rumour, the fuselage is said to be considerably longer than hitherto supposed and to be roughly similar in size to



"Flying Pig," a wingless VTOL vehicle (with developed BS.53) for anti-submarine duties, as proposed by Dr. S. G. Hooker. 1 – Air intake; 2 – secondary ducts for the BS.53; 3 – primary air ducts; 4 – jet nozzles for pitch stabilization and yaw control; 5 – jet nozzles for roll stabilization; 6 – military payload; 7 – fuel tank; 8 – ejection seat.

the *Hunter*. Unlike the latter, however, the aircraft probably has a high-set wing, to ensure that jet efflux is not hampered by the wing in the VTOL case. It can probably also be assumed that the P.1127 will not exceed high subsonic speeds, but Sir Sidney can certainly be expected to have at least one more iron in the fire.

• **Lightweight lift engines:** Power/weight ratios of 14: 1 and 16: 1, such as are in view at Bristol Siddeley and Rolls-Royce, seem almost unrealistic, compared with the much lower figures achieved in even the latest lightweight propulsion engines. I therefore asked the experts—*Dr. S. G. Hooker*, of Bristol Siddeley, and *Mr. A. C. Lovesey*, of Rolls-Royce—how this is done. Their replies revealed that the first requirement is an ultrashort combustion chamber. After all, lift engines need fire and operate only near the ground; they are not required in the stratosphere. Secondly, a certain loss in combustion efficiency, i.e., a slightly higher fuel consumption, can be accepted. It follows that a moderate compression ratio suffices, and this can be achieved by, say, a six-stage lightweight axial compressor with single-stage turbine. As, however, compressor, combustion chamber and turbine are very short, it is possible to manage with two bearings, and the heavy centre bearing usually required in high-power engines can be dispensed with. Wherever possible, the lightest materials are used, e.g., fibreglass. Finally, as these lift engines are always required to operate at full thrust, the regulation system

can be restricted to a simple overspeed control; if a free aft fan and exhaust-driven turbine are added, the full thrust can be improved by a further 35 to 40 percent for a very small weight penalty.

Mr. A. C. Lovesey again stressed in this connection the advantages promised by the Rolls-Royce scheme for combining ultra-light lift engines with high-power propulsion engines. The latter can be in the form of multi-stage twin-compressor engines and be designed for minimum fuel consumption at high altitudes; they would thus be superior, from the point of view of economics, to the lift-plus-propulsion engines with rotating nozzles.

In the meantime, however, *Dr. S. G. Hooker* has a new field of application to suggest for the BS.53 lift-plus-thrust engine now being built at Bristol Siddeley (and already fitted in the P.1127): an anti-submarine "Flying Pig" which could cruise for up to 40 minutes waiting for its target and drop a 3,000 lb load of explosives on it. It would be controlled on the Short principle by a pilot, equipped with ejection seat and parachute, and compared with the helicopter would be not only space saving, but also above all less vulnerable and altogether safer.

The regrouping of the industry

The latest moves in the reorganization of the British aircraft industry were described to us over lunch by *Mr. Alexander Johnston*, the genial head of SBAC's Press and Information Department. The details are shown in the list earlier in this article, and the accompanying map indicates the locations of the most important plants. No essential changes have occurred since the last account was published in these pages[6], except that the *Airco* consortium has been dissolved, and the new group formed by Vickers Armstrongs (Aircraft), English Electric Aviation, Bristol Aircraft and Hunting Aircraft has been given the name *British Aircraft Corporation*.

We also learned from company representatives what are the net assets behind the two big groups in the airframe industry, in each case counting the considerable non-aeronautical production divisions: these are £233 million for BAC, and roughly £120 million for the Hawker Siddeley Group. One interesting point is that British aircraft will continue to bear the name of the company responsible for their design and development, e.g., Hunting 107 or DH.121. Each of the two groups has, however, a central planning office to initiate and coordinate development programmes. New orders will be placed with the parent organization, but the individual member companies will, at any rate for the time being, continue to deal with orders already in hand. The helicopter group is already dominated by the name *Westland Aircraft Ltd.*, and the companies merged in this group will be known in future as Saunders-Roe Division, Fairey Division and Bristol Helicopter Division.

Bristol Siddeley Engines Ltd., formed over two years ago by the merger of Armstrong Siddeley Motors and Bristol Aero-Engines, is now well established. The company's engines bear the designation "BS" (instead of the earlier "AS" or "BE"). Bristol Siddeley and its rival, *Rolls-Royce (Aero Engine Division)*, form the backbone of the British aircraft engine industry, although there are also four smaller companies in this field: *Blackburn Engines* and *de Havilland Engines* (both members of the Hawker Siddeley Group), *D. Napier & Son* (a member of the English Electric group, but not of British Aircraft Corporation), and *Alvis Ltd.*

Alongside the "big five" and the two independent engine companies just mentioned, there are another six unattached firms in the airframe industry. These vary considerably in size and are engaged in producing either aircraft or missiles. In alphabetical order they are: Auster Aircraft, Handley Page, Lancashire Aircraft, F. G. Miles, Scottish Aviation, and Short Brothers & Harland.

Obviously it is quite impossible in seven working days to "inspect" the whole of so ramified an industry, which employs roughly a quarter of a million men and women and has main and branch plants spread over almost the whole of the United Kingdom's 94,000 square miles. My visits therefore had to be confined to some of the main plants of the airframe industry (during the first five days) and the two major engine manufactures (on the other two). Reports from London Editor *Derek H. Wood* have been used to fill in the gaps.

In the workshops . . .

Both Derek and I were grateful that we were not obliged to rely on British Railways for our trips to the more distant plants. To reach the English Electric research and flight test installations at Warton (near Preston, Lancs.), we were able to use the English Electric executive aircraft, a *Dove* chartered from Silver City. Take-off was from the Vickers airfield at Wisley (near Weybridge, Surrey), where *Alan Brothers*, English Electric Public Relations Manager, was awaiting us. The cross-country journey from Warton near the west coast to Hull on the east was made in 3½ hours in a comfortable limousine belonging to Blackburn, and we were taken back to London in the Blackburn *Dove*, which landed at Hatfield... incidentally in weather in which even the birds had to walk. Inter-company travel within the British Aircraft Corporation and the Hawker Siddeley Group —not to mention several other companies— seems to run very smoothly. One thought struck us: with the many abandoned wartime RAF airfields we saw, all of them with concrete runways and situated within relatively easy reach of some of the bigger cities, would not short-distance commercial services one

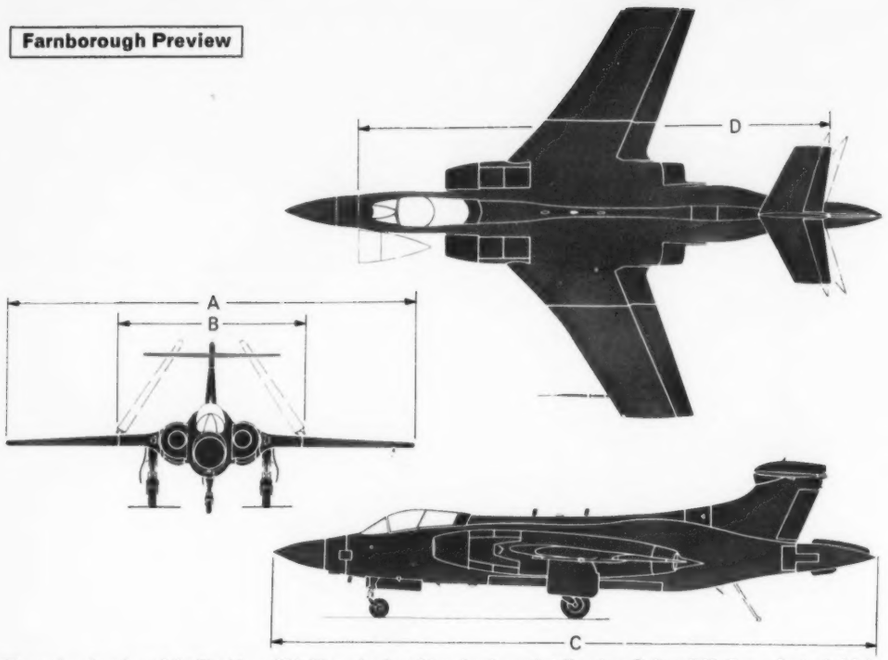
[6] "Streamlining Britain's Aircraft Industry," in *Interavia* No. 3, 1960, p. 288 etc.

Avro 748 medium-stage aircraft (two Rolls-Royce *Darts*). By the end of July the first aircraft had logged 60 flying hours.

Armstrong-Whitworth *Argosy* (four Rolls-Royce *Darts*).

Handley Page *Dart Herald*.

The two-seat Folland *Gnat Trainer* (BS *Orpheus*) has been ordered by the Ministry of Aviation (total of 44) and will be used for fighter training in the RAF.



Three-view drawing of the Blackburn NA.39 carrier-based low-level naval strike aircraft (two DH. *Gyron Juniors*). Main dimensions: span (A) 42 ft 4 in., or 19 ft 11 in. in folded state (B); length (C) 63 ft 5 in., or 50 ft 3 in. with folded nose and air brakes open (D).

day be a profitable proposition in this densely populated country?

• **English Electric Aviation:** Warton is a beautifully equipped former USAAC bomber base, whose main runway measures a full 9,300 ft. It also has a secondary runway 3,900 ft long, which forms an angle of 60 degrees with the main runway. We particularly admired the new Marconi S.264 surveillance radar, with its low-set antenna rotating just above the airfield surface. Contrary to the inventor's original plan, this equipment is also used as a precision approach radar. Its main task is, of course, to guide departing or landing *Lightning* fighters through the controlled airspace around Preston, within a range of 110 nautical miles (at 30,000 ft altitude). In addition, when working on the 16 nautical mile range scale, it can follow landing aircraft to within a distance of one nautical mile from touchdown and talk them down safely. Other installations: three VHF D/F links (Marconi AD.200) and two UHF links (Standard CADF); Eureka beacon; Pye ILS. And last but not least, a fire-fighting group at constant stand-by and a *Sycamore* rescue helicopter.

The pride of English Electric are the wind tunnels at Warton. Besides one large and two smaller subsonic tunnels, there are two supersonic tunnels for Mach numbers of up to 6 (for missiles) and 4 (for aircraft). The Mach 6 tunnel has a test section of 15 inches by 20 inches and a continuously adjustable nozzle; flow time 15 seconds, sufficient to record 14 parameters on each of 25 punched cards. Forces are taken up by a six-component balance with electrical strain gauges.

Standing around the airfield and in the adjoining hangars were some dozens of P.1 *Lightnings*. These were of several different Marks, for example P.1B and two-seat T.4; no further details have, however, been released. We also learned that the RAF's 74 Squadron at Coltishall is already equipped with the P.1. Nearly all the aircraft we saw had the characteristic plastic cone in the air intake to take the antenna group of the *Airpass* air interception and pilot's attack sight system, which Ferranti has meanwhile developed still further to fulfil the dual role of attacks on both air and ground targets.

A Blackburn NA.39 lands on the aircraft carrier HMS "Victorious" (January 1960).

This led us to ask *Mr. Freddy W. Page*, English Electric Aviation Chief Executive, what he thought about the P.1 as a fighter-bomber. On this point he was not ready to commit himself. He said: "The *Lightning* is a very advanced weapons system for aerial defence, designed to sweep all intruders from the skies who do not come within the range of the *Bloodhound* batteries. It can also engage the enemy well beyond our coasts, in any weather and with automatic control from ground stations. We fully understand that, with their limited resources, our European allies should be interested in multi-purpose fighters which can not only be used for air defence but can also carry out attacks on ground targets. It is also conceivable that the RAF may one day use the P.1, like the *Hunter*, in the strike role. I should merely like to say that the P.1 is robust enough structurally for this work." It can reportedly carry a heavy bomb or missile load and, if fitted with external tanks, would have a respectable radius of action.

On the way from Warton to Hull we drove past English Electric's final assembly plant (and airfield) at Samlesbury, where P.1s are on final assembly, and production of the *Canberra* in several versions (high-altitude reconnaissance, intruder, trainer) is continuing.

• **Blackburn Aircraft:** In *Brough*, a small village not far from Hull, on the northern bank of the Humber, we came unexpectedly upon a large, modern factory where production of the NA.39 carrier-based two-seat strike aircraft is going full speed ahead. Since its public début at last year's Paris Air Show, the NA.39 has been developed into a complete weapons system, with Ferranti radar in the nose, doppler radar aerials beneath the nose, Naval TACAN equipment, etc. It already has a first phase of deck trials behind it—aboard HMS "Victorious" in January 1960—and about half of the pre-production series are already flying. At present powered by two D.H. *Gyron Juniors*, the NA.39 may well accept a second generation engine, thanks to its built-in development capacity. There is talk of a military version of the Rolls-Royce RB.163 bypass jet in the "10,000 lb-plus" thrust class; such an engine could give a considerable increase in the already impressive radius of action. The possibility of fitting auxiliary fuel tanks has been taken care of. Armament consists of bombs or mines carried in a rotating bay, and may be supplemented by underwing air-to-surface missiles.

Several of Britain's allies are showing continuing interest in the NA.39, in particular the West German Navy for operations in the Baltic. The Germans might possibly dispense with folding wings, since they have no aircraft carriers, but this need not prevent landings on carriers belonging to other NATO countries. The NA.39 could perhaps be used as a carrier-borne Naval fighter, doubtless having supersonic speed at altitude. For the NA.39 Blackburn is known to have developed

extensive facilities for machine and chemical milling.

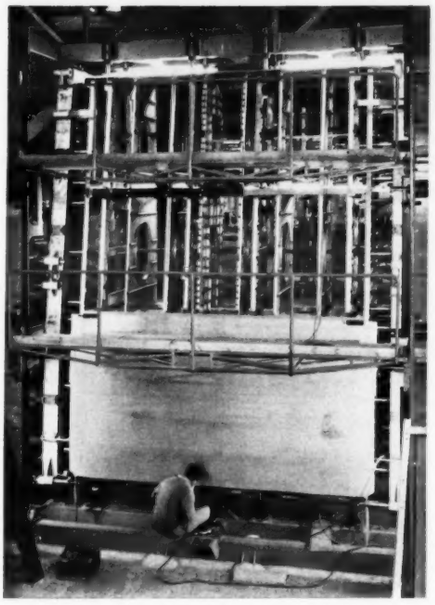
Much of interest was to be seen on a quick tour of Blackburn Engines Ltd., where numerous small gas turbines and auxiliary power units are in production, some of them under Turboméca licence, others of original Blackburn design (e.g. A.129). Unfortunately, there was no time left for a visit to the nearby Blackburn Electronics Ltd.

A lunch in the company of Joint Managing Directors *N. E. Rowe* and *Captain E. D. G. Lewin (R. N.)*, who were also joined by *Air Commodore F. R. Banks* (Blackburn director), Chief Designer *B. P. Laight* (also a director) and Sales Manager *Major C. H. Vallance*, gave us an opportunity to ask more questions, all of which were answered in very friendly manner and some in full. We heard about the almost fairy-tale project for the Blackburn SP.60 crane helicopter for a payload of 50 tons. Power would be supplied by six freely rotating BS jets feeding six blade-tip nozzles (the crane "driver" will sit in one of the undercarriage legs). Here the main job is not so much to overcome design difficulties, but rather to break through the "imagination barrier." A lively discussion on trends in engine design took place with Air Commodore Banks, who as Director of Research and Development at the Ministry of Aircraft Production during the war and again in the Ministry of Supply in 1952–53, was largely responsible for the planning and programming of the generation of British turbine engines currently in use.

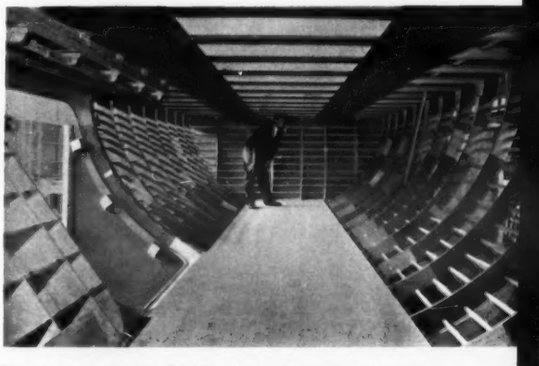
Finally, a few minutes' drive took us to the idyllically situated former RAF Station Holme-on-Spalding Moor, where Blackburn's test flying takes place. Half a dozen NA.39s were standing on the field or could just be discerned behind the half-open hangar doors. Here Chief Test Pilot *D. J. Whitehead* gave us a few details of the deck landing trials, and then the waiting *Dove* bore us aloft, exactly to works schedule.

• **Vickers-Armstrongs Aircraft:** Located round the old Brooklands motor racing track, Vickers' Weybridge factory hums with activity. With its wind tunnels and test beds, its giant metal working and assembly sheds, its up-to-date equipment and, by no means last, its extensive design offices, it is one of Britain's most imposing aircraft plants. I was most particularly impressed by the skin milling machines (built in Britain under U.S. Marwin licence), which convert duralumin plates measuring up to 40 ft in length and generally 2½ inches thick into integrally stiffened wing skins. In the case of the *Vanguard*, these plates are 27 ft long, in that of the VC.10 as much as 34 ft. In the rough state they weigh some two tons, but are reduced to around 350 lb by the time they are fully machined. To ensure that they accurately match the required airfoil, they are then curved in a shot-peen machine by means of a stream of compressed air carrying very fine steel shot. At the same time this process produces a hardening of the surface.

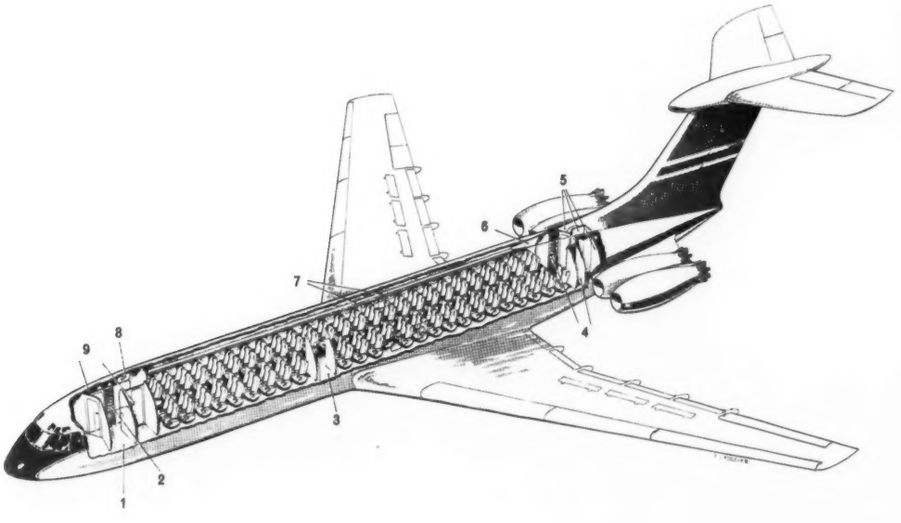
In the metal-working shops the first four or five VC.10s of the pre-production batch are taking shape. The sheer size of the fuselage cross section is enough to take one's breath away, and the jigs tower up like a cathedral, almost touching the roof. Gazing at this giant toy, I had no difficulty in understanding why the traditional methods of building an experimental model by hand and testing it step by step is now definitely a thing of the past, at any rate where large aircraft are concerned. The days of prototypes are gone, for today's air transport monsters can be constructed only in sturdy, production-type jigs. Quite apart from this, flight testing of the airframe and the many airborne systems has meanwhile become so complicated and so time-consuming that several aircraft must be available for simultaneous testing. Otherwise the designers run the risk that their creation is already "out of fashion" by the time it finally gets its certi-



The VC.10 wing centre section in the jig. The triple torsion box consists of integrally stiffened components and forms one of the many fuel tanks.



Six-abreast seating in the passenger cabin and very roomy freight holds are typical features of the VC.10. Pictures show parts of the full-scale mockup of this aircraft.



◀ Standard version of the Vickers VC.10 for 150 passengers. 1 – Forward main passenger door; 2 – miscellaneous stowage; 3 – rear passenger door; 4 – miscellaneous stowage; 5 – toilets; 6 – servicing and emergency exit door; 7 – emergency exits (two per side); 8 – servicing and emergency exit door; 9 – passenger toilets.

ficate of airworthiness. The very first model must therefore hit the mark... or the manufacturer will be ruined. One more reason why design experience has become an invaluable asset.

In this state of affairs, British Aircraft Corporation's manufacturing and development programme for commercial aircraft, led by Vickers, strikes one as being unusually widespread. Leaving aside the *Viscount* (424 aircraft ordered; 417 delivered) and *Vanguard* (43 ordered), the latter company has 35 VC. 10s in production for BOAC, and these will be followed by 10 Super VC.10s with longer fuselage and more powerful *Conway* engines. We learned from conversations with *Sir George Edwards* and *Mr. Charles Gardner* (BAC's Publicity Manager) that the following studies are also in hand at BAC: 1. *pure freight VC.10* (with swing nose?); 2. *VC.11 medium-range jet aircraft,* a scaled-down derivative of the VC.10 with four advanced Rolls-Royce RB.163s, accommodation for 100 passengers and block distances of 2,600 nautical miles; 3. *Hunting 107* short-stage jet airliner, with two BS.75 bypass jets. Market prospects for the Hunting 107 are regarded as very good[7], and Bristol Aircraft's factory at Filton would obviously have ample capacity available to produce it in quantity. The RAF is also considering a military transport version of the Super VC.10, which could possibly be used as a carrier for the *Sky Bolt* air-launched ballistic missile.

British Aircraft Corporation's most urgent and important project, however, is in the purely military field and is being pursued at full pressure by a combined team of experts from English Electric and Vickers-Armstrongs in Weybridge: this is the *TSR.2* tactical strike and reconnaissance aircraft, apparently with delta wing. Powered by two developed *Olympus* engines, this aircraft will, according to Sir George Edwards, have three basically different advantages: 1. it will be able to take off from any runway measuring 1,800 ft or more in length; 2. carry out low-level attacks with full military load and over long ranges; 3. reach Mach numbers of around 2.5 at altitude. Its long range suggests that it will be suitable not only for tactical strike missions in and near the combat zone, but also for strategic tasks.

A de Havilland *Comet 4B* (four Rolls-Royce *Avons*) in BEA colours.

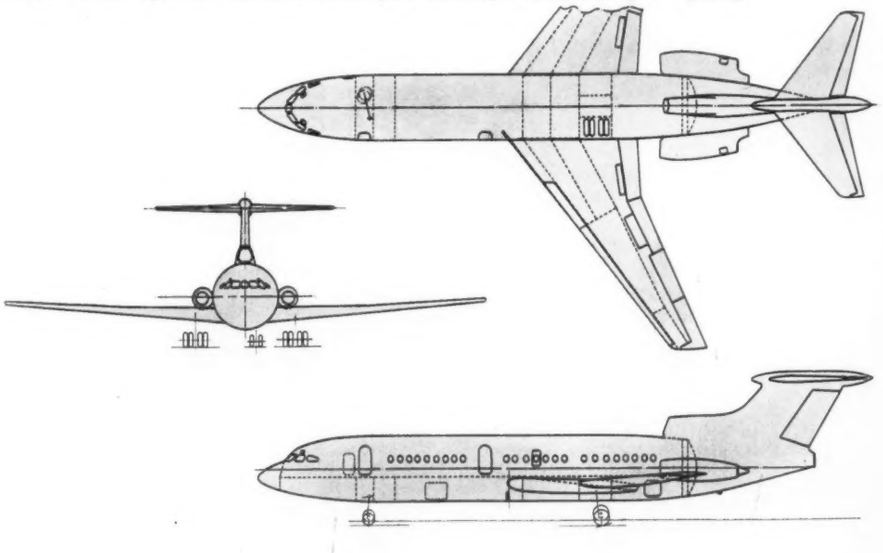
The first Vickers *Vanguard* (four Rolls-Royce *Tynes*) for Trans-Canada Airlines.

• **De Havilland Enterprise:** This member company of the Hawker Siddeley Group has three subsidiaries—de Havilland Aircraft, de Havilland Engines and de Havilland Propellers—located in and around Hatfield, Hertfordshire, as well as branches at Christchurch and Portsmouth, Hampshire. However, we were able to visit only the first-mentioned. The works is about to celebrate in suitable manner the 50th anniversary of the successful maiden flight by the first aircraft designed and flown by *Sir Geoffrey de Havilland* (the story of de Havilland is told elsewhere in this issue). From the *BE* (British Experimental) biplane of 1910 to the latest *Comet 4* jet airliner (for BOAC, Aerolineas Argentinas and East African Airways), the *4B* (for BEA and Olympic Airways) and the *4C* (for Mexicana, MEA and Misrair) of 1960, more than a hundred different types and tens of thousands of individual aircraft have carried the world-famed D.H. initials. And as regards the last three versions of the *Comet,* Sales Manager *Frank H. M. Lloyd* is confident that the present order book for 51 aircraft can be extended by another good dozen.

The latest offspring of the D.H. family, the DH.121 short-range jet airliner for stage distances of between 200 and 1,200 miles, is now in the pre-production stage. It is expected to fly before the end of 1962 and go into airline service from 1963 onwards. BEA has ordered a total of 24 of these aircraft, which have accommodation for 79 passengers in mixed-class operations or 97 in economy-class operations. Maximum cruising speed will be 526 knots at 25,000 ft. An advanced model, *Version 2,* with longer fuselage, greater seating capacity (97 passengers in mixed-class configuration) and longer maximum range is also offered.

In my tour round the full-size mockup of the DH.121 I had a very competent guide in the person of *Mr. J. P. Smith,* assistant to Chief Designer C.T. Wilkins. Overall impressions: the droop-snoot wing leading edge, which is actuated jointly with the double slotted flaps, struck me as being a particularly happy aerodynamic advance, since it on the one hand makes for good maximum lift and hence short landing distances, and on the other ensures that the incidence of the aircraft longitudinal axis scarcely changes during the landing approach. As soon as the wheels touch the ground, the remaining wing lift is reduced practically to zero by means of two "lift dumpers," a kind of spoiler, which lie in front of the flaps and are raised within a fraction of a second. This system makes sure that the wheel brakes attain their full efficiency immediately. In addition there are conventional air brakes and thrust reversers, to reduce the landing run still further. As an angle of sweep of 35 degrees and an aerodynamically "clean" wing were chosen, the design Mach number for altitudes above 25,000 ft is no less than 0.875. A slight inverse cambering in the wing centre section ensures that flow first begins to break away in this uncritical region. The outer wing sections carry two pairs of ailerons, only the inboard pair of which operate during high-speed flight. Further innovations were to be seen right in the front and right at the back of the mockup: on the flight deck one is struck by the positions on the instrument panel marked "Autoflare" and the toy-like spirals of the Smiths Para-Visual Director, and in the pressure-tight bulkhead at the rear of the passenger cabin one discovers a thick glass window through which the centre engine (Rolls-Royce RB.163) and a large portion of the triplicated hydraulic system can be inspected. Finally, mention should be made of

Three-view drawing of the de Havilland DH.121 (three Rolls-Royce RB.163s) for up to 97 passengers.



[7] Cf. "The Small Jet Airliner—the Need and the Answer," in *Interavia* No. 10, 1959, p. 1255 etc.

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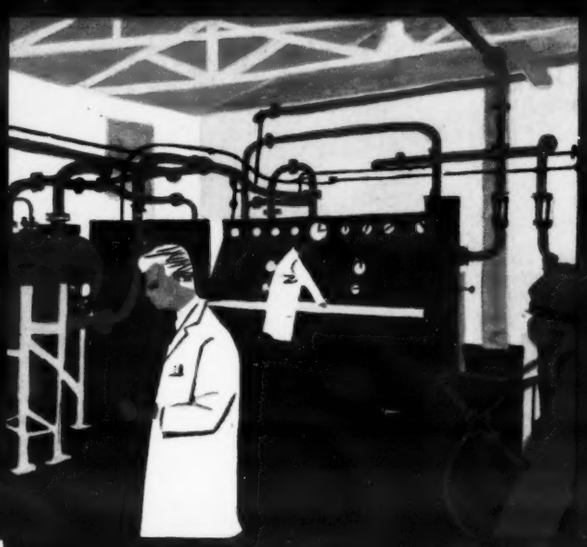
10,000-gallon AIR BP SUPERFUELLER in service in 1960

INTO THE SIXTIES . . .



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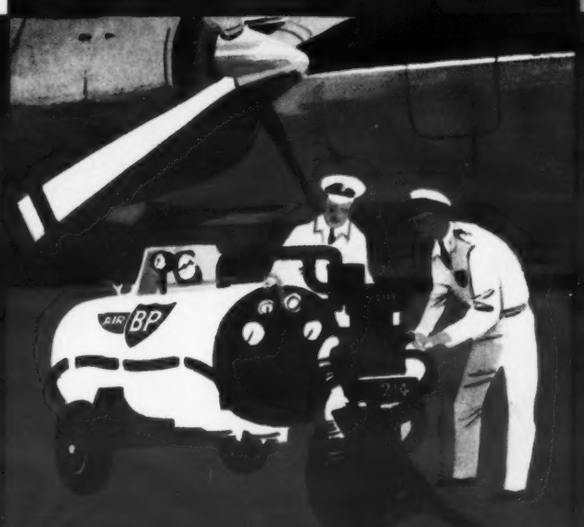

The Intercontinental Comet 4 with 4 Rolls-Royce Avon engines.

24 Airco DH 121 airliners are on order for BEA.

The Vickers VC. 10 will be entering service with BOAC in 1963.

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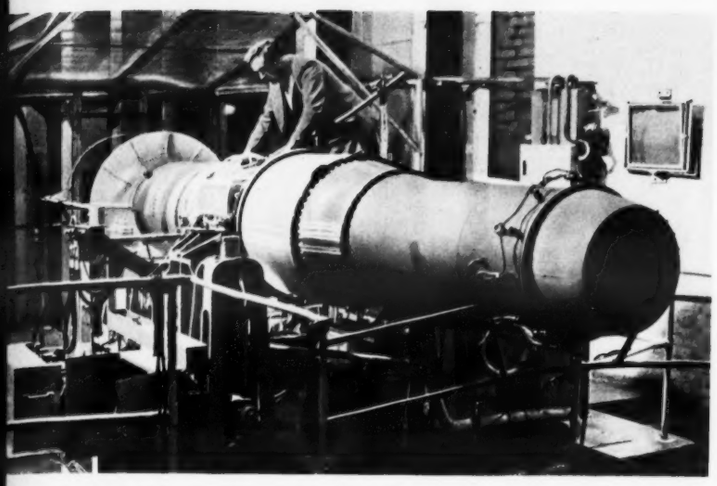
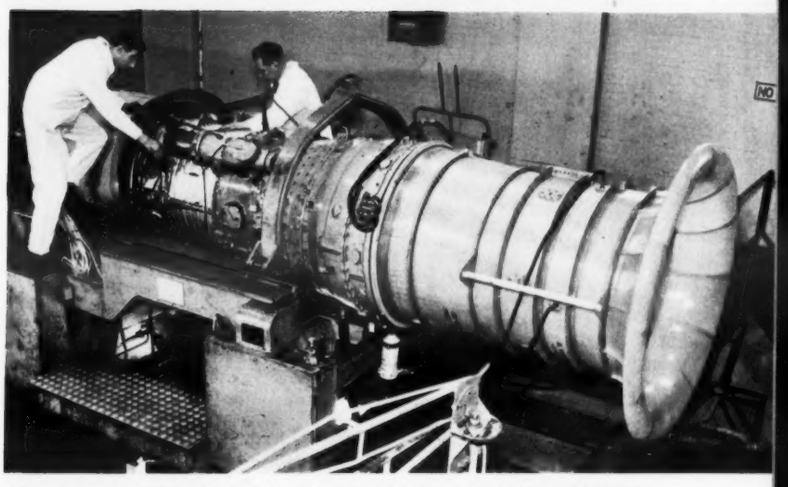


Bristol Siddeley seems to be well satisfied with sales of the *Orpheus*, the BOr.12 version of which delivers 6,810 lb of thrust without reheat, or 8,170 lb with. Bare engine weight is 1,110 lb; fuel consumption on the test bed 0.933 lb/lb/h.



Even without reheat the Bristol Siddeley *Olympus 21* delivers a static thrust of 20,000 lb. With reheat sea level static thrust is probably some 40 percent higher. Note the fibre-glass air intake.

the Blackburn auxiliary power unit which is installed to provide air conditioning and power supply for the DH.121 when on the ground.

The manufacturing methods used at de Havilland differ from those employed at Vickers in that marked preference is given to Redux metal bonding. Just the same, the number of sheet metal parts which must be mechanically or chemically treated is still considerable.

• **Bristol Siddeley Engines:** Whereas on our visits to the aircraft manufacturers we had been interested primarily in the mockups of coming aircraft types and in modern production methods, in the engine industry our chief desire was to see the test beds and research laboratories. This desire was met, and in the company of *Mr. W. Eustace,* Sales Liaison for Bristol Siddeley, and *Mr. Dick Butcher,* the company's press officer, we were able to admire the high altitude test plant for ramjets, which cost some £1 million to erect and is designed to simulate Mach numbers of up to 4 and altitudes from zero to 100,000 ft. Ramjet engines of the *Thor* variety (powerplant for the *Bloodhound* surface-to-air missile) have been undergoing flight tests at Bristol since 1952; it is therefore understandable that the company should have done everything in its power to supplement and replace costly high-speed tests in the stratosphere by ground tests.

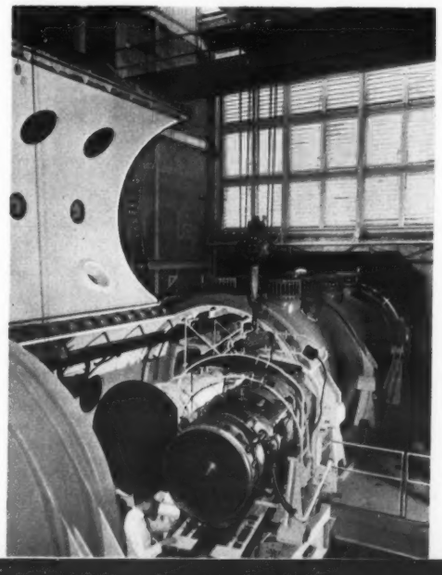
The heart of the test plant, which was inaugurated some two years ago, is a chamber of inch-thick steel plates weighing more than 100 tons, with water-cooled glass windows for inspection purposes. The ramjet under test is mounted on a swinging stand in front of a nozzle which provides an air stream of the appropriate Mach number... and is cooled during operation by water under pressure. Pressure inside the test chamber is regulated to simulate altitude (practically down to an absolute vacuum if required) by means of six powerful steam ejectors which, fed from four cylindrical Roots steam accumulators, exhaust into a giant "factory chimney" and let loose a mighty cloud of steam. For high-altitude conditions (above 50,000 ft), the required air velocity is obtained from the suction effect of the vacuum in the test chamber, but for lower simulated altitudes the air is supplied by blowers with a total maximum power of 26,000 h.p. In both cases the air is first heated or cooled to the desired operating temperatures (ram temperature) at the engine air intake.

Some idea of what Bristol Siddeley has ready in the way of high-power engines for the manned military aircraft of tomorrow—second generation "V" bombers and TSR.2—was obtained from rapid glimpses of two of the many test beds for production engines. In one of these an *Orpheus* was humming comfortably on an endurance run at full power—a mere 6,800 lb—in the second the test engineer was in the process of testing an afterburning *Olympus*: a stream of bluish flames, a mighty roar, and the pointer on the thrust indicator, which had been virtually at rest at 20,000 lb, went speeding upwards...

• **Rolls-Royce, Aero Engine Division:** The position which Rolls-Royce has attained in civil aviation during recent years was discussed with *Air Marshal Sir Colin Weedon,* General Manager—Commercial Sales. We gathered from him that more than 70 percent of the turbine-powered aircraft sold throughout the world during the past two years are flown on Rolls-Royce engines (306 out of a total of 430). The *Dart* turboprops in the 389 *Viscounts* in commercial operation have totalled nearly 12 million flying hours. At the same time the *Dart* has set the absolute record for operating reliability, with an overhaul life of 2,700 hours (with TCA), while the civil *Avon RA.29s* used in the *Comet* and *Caravelle* are not far behind with an overhaul life of 2,000 hours. These figures reveal clearly that even one or two years of operation in air transport provide far more operating experience of an engine type than ten years' use by the military services. Commercial aircraft are in the air for several thousand hours year in year out, while military aircraft as a rule do not achieve more than a few hundred hours a year.

Like Bristol Siddeley, Rolls-Royce also has a giant "show piece" in the shape of a high-altitude test plant for jet aircraft, simulating altitudes of up to 70,000 ft and Mach numbers of up to 2.5. It is said to have cost no less than £5 million. At the present time it is being used primarily to test a new generation of bypass engines, to continue the good work begun by the *Conway* in civil airline operations: RCo.42 for the VC.10, RB.141 for the *Caravelle VIII,* RB.163 for the DH.121.

The pride of Rolls-Royce Aero-Engine Division is the mighty high-altitude test chamber at Derby, which is said to have cost nearly £5 million. It simulates altitudes of up to 70,000 ft and Mach numbers of up to 2.5. Picture shows the test chamber open, with a *Conway* bypass engine inside.



The other aircraft companies

If the writer must now deal with the remaining aircraft, missile and engine firms more briefly, this is not merely for space reasons, but also because he was not able personally to study their programmes and products. *Interavia* hopes to make this good in coming years.

• **Armstrong Whitworth Aircraft** (Hawker Siddeley Group): Here the main effort is being put into producing and further developing the *Argosy* freighter (four Rolls-Royce *Darts*) which is offered in two different versions: civil *Argosy* and AW.660 military transport. A STOL *Argosy* is at the design stage. A firm order has already been received from Riddle Airlines, which may well open the gates to the American freighter market.

I — Civil aircraft (under development or test)

Manufacturer and type	Engines (number and take-off power)	Span ft.in.	Length ft.in.	Wing area sq.ft.	Take-off weight lb	Pas-sengers	Max. pay-load lb	Max. cruise speed kts	Typical range n.m.
Armstrong Whitworth AW.650 *Argosy*	4 × Rolls-Royce *Dart 526* (RDa.7/2) 4 × 2,100 eshp	115′	86′ 9″	1,458	88,000	71/83	28,000	~240	~1,000
Avro 748 Series 1	2 × Rolls-Royce *Dart 514* (RDa.6) 2 × 1,740 eshp	95′	67′	795	33,000	40/48	9,670	~230	500/600
De Havilland DH.121	3 × Rolls-Royce RB.163 3 × 10,100 lb	89′ 10″	114′ 9″	1,350	105,000	75/97	21,500	530	1,500
Handley Page *Dart Herald*	2 × Rolls-Royce *Dart 527* (RDa.7) 2 × 2,100 eshp	94′ 9½″	71′ 11″	866	39,000	38/47	13,300	245	~1,000
Hunting 107	2 × Bristol Siddeley BS.75 2 × 7,000 lb (?)	—	—	—	—	44/55	—	—	—
Short SC.5 *Britannic*	4 × Rolls-Royce *Tyne RTy.12* 4 × 5,730 eshp	158′ 9½″	136′ 5″	2,466	218,000	—	85,000	330	3,000-3,500
Short SC.7	2 × Lycoming piston engines	64′ 3″	38′ 9″	373	8,250	up to 15	3,000	130-150	—
Vickers VC.10	4 × Rolls-Royce *Conway RCo.42* 4 × 20,250 lb	140′	158′ 10″	2,800	299,000	up to 150	38,000	500 +	4,000-4,500
Vickers Super VC.10	4 × Rolls-Royce *Conway RCo.42/2* 4 × 20,250 + lb	146′	186′	2,800	347,000	up to 212	58,000	500 +	4,000-4,500
Vickers VC.11	4 × Rolls-Royce RB.163 4 × 10,100 + lb	—	—	—	170,000	—	—	~540	~2,500

II — Helicopters (under development or test)

Manufacturer and type	Engines (number and take-off power)	Rotor dia-meter ft.in.	Length ft.in.	Weight lb	Seats	Max. pay-load lb	Max. cruise speed kts	Typical range n.m.
Blackburn crane helicopter SP.60	6 × Bristol Siddeley	—	—	—	—	100,000	—	to 300
Bristol 192C *Belvedere*	2 × Napier *Gazelle 2* 2 × 1,650 shp	48′ 8″	90′	18,500	up to 24	—	120	400 to 500
Bristol 194	2 × Napier *Gazelle*	—	—	~20,000	—	—	~140	—
Bristol 214	2 × de Havilland *Gnome*	—	—	—	16	—	—	—
Fairey *Tyne-Rotodyne*	2 × Rolls-Royce *Tyne* 2 × 5,250 shp + 4 × Fairey pressure jets	104′	64′ 6″	53,500	65/70	18,500	200	~500
Saunders-Roe P.531 *Wasp*	1 × Blackburn A.129 *Nimbus* 1 × 885 shp	32′ 3″	39′ 8″	5,000	5—6	—	105	~250
Saunders-Roe *Turmo-Skeeter*	1 × Blackburn *Turmo 603* 1 × 425 shp	32′	39′	2,350	2	—	~90	~100
Westland *Westminster*	2 × Napier *Eland E.229A* 2 × ~2,800 shp	72′	89′ 3″	33,000	up to 40	12,700	~130	100 to 150
Westland *Westminster* crane helicopter	2 × Napier *Eland NEI.6* 2 × 3,650 shp	—	—	33,000	up to 45	—	up to 130	up to 350
Westland *Wessex 2*	2 × de Havilland *Gnome* 2 × ~1,050 shp	—	—	—	—	—	—	—
Westland *Gnome-Whirlwind*	1 × de Havilland *Gnome* 1 × ~1,050 shp	53′	44′ 2″	8,000	8—10	1,850	90	~250

III — Research aircraft (under development or test)

Manufacturer and type	Engines (number and take-off power)	Remarks
Bristol T.188	2 × de Havilland *Gyron Junior DGJ.10* 2 × 14,000 lb	For aerodynamic and structural tests on kinetic heating of airframe at high speeds (Mach 2.5 to 3). Airframe of stainless steel, partially ceramic coated. Span 35 ft 1 in.; wing area 396 sq.ft.; thickness/chord ratio 4%.
Hunting "Jet Flap"	—	Experimental aircraft, reportedly equipped with ducted fan engines.
Handley Page HP.115	1 × Bristol Siddeley *Viper*	All-wooden research aircraft for low-speed tests, due to fly this year.
Hawker P.1127	1 × Bristol Siddeley BS.53	P.1127 is conceived as predecessor to a V/STOL aircraft to meet NATO specifications for the third-generation strike fighter.
Short SC.1	5 × Rolls-Royce RB.108	Four RB.108s (2,130 lb thrust) for lift, plus one RB.108 for propulsion. The SC.1 is the first stage in a broad development programme for high-speed VTOL aircraft.
Vickers *Swallow*	—	Project by Dr. Barnes Wallis for a supersonic airliner with variable-sweep wing.

IV — Military aircraft (under development or test)

Manufacturer and type	Engines (number and take-off power)	Remarks
Avro *Vulcan B.2*	4 × Bristol Siddeley *Olympus 201* 4 × 17,000 lb	Compared with *Vulcan B.1* has longer span, modified planform and new rear fuselage to take additional electronic equipment. Later, advanced *Olympus* to be used (dry thrust 20,000 lb, or 28,000 lb with reheat).
Avro *"Phase Six" Vulcan*	4 × Bristol Siddeley *Olympus*	Fuselage as for B.2; modified wing; for high subsonic cruise speed over very long ranges and altitudes of above 68,000 ft. Armament, *Sky Bolt* ALBM.
British Aircraft Corp. TSR.2	—	Two advanced Bristol Siddeley *Olympus* with reheat.
Folland Fo.144 *Gnat Trainer*	1 × Bristol Siddeley *Orpheus BOr.4;* 1 × 4,230 lb	Ordered for RAF; transonic speed at altitude.
Handley Page *Victor B.2*	4 × Rolls-Royce *Conway RCo.11* 4 × 17,250 lb	Modified planform and bigger air intakes compared with *Victor B.1* (B.S. *Sapphire*, 11,000 lb thrust).

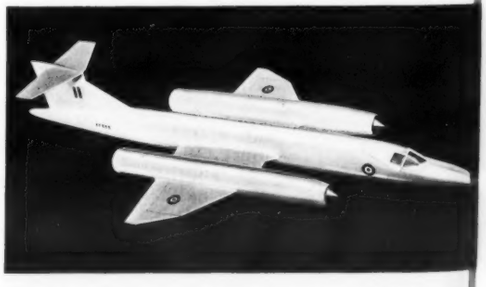
The Scottish Aviation *Twin Pioneer* is in demand all over the world. It is already operating with the RAF, a number of aerial photographic companies (Switzerland, Austria, etc.) and on Germany's Taxiflug services to the North Sea resorts.

• **Alvis Limited:** This company has the *Leonides* and *Leonides Major* piston engines in production, in versions for fixed-wing aircraft, helicopters and hovercraft. Cross-country chassis for airfield fire engines are another major product.

• **Auster Aircraft:** Manufacture of army observation aircraft, agricultural aircraft *(Agricola)* and sports and touring aircraft *(Aiglet,* etc.).

• **Bristol Aircraft** (British Aircraft Corporation): *Britannias* on overhaul; research on supersonic transports; final assembly of the Bristol T.188 research aircraft, due to begin flight testing shortly; *Bloodhound Mk. 1* surface-to-air missiles and advanced models.

• **De Havilland Propellers** (Hawker Siddeley Group): Production and advanced work on *Firestreak* air-to-air homing missile, a new version of which, the *Red Top* (with omni-directional infra-red homing system), is said to have become operational; the latter can be fired with the fighter in practically any position in relation to the target.



The Bristol Type 188 supersonic research aircraft (two DH. *Gyron Juniors* with reheat), constructed of stainless steel.

• **Gloster Aircraft** (Hawker Siddeley Group): Now mainly industrial, but modifications, production of spares, and repairs to the Gloster *Javelin.*

• **Handley Page:** Production of the *Victor Mk.2* "V" bomber; construction of a small batch of *Dart Heralds;* development of the HP.115 research aircraft with BS *Viper* and thin delta wing, designed especially for low-speed trials for supersonic airliners.

Westland *Belvedere* (Bristol 192) military helicopter, now powered by two Napier *Gazelle* shaft turbines. A civil version designated 194 is in preparation.

The second prototype of the Westland *Westminster* heavy helicopter (two Napier *Elands*, has a six-blade rotor.

• **Hunting Aircraft** (British Aircraft Corporation): Production of the *Jet Provost* RAF trainer (with BS *Viper*); development of a jet flap research aircraft and of the Hunting 107 project.

• **Lancashire Aircraft:** Construction of the *Prospector* agricultural aircraft, now with 295 h.p. Lycoming engine.

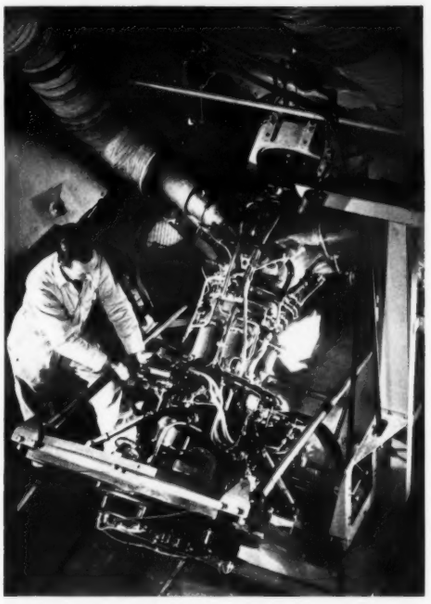
• **F. G. Miles:** Development of the M.100 *Student* jet trainer, the jet-powered *Centurion* five-seat touring aircraft and new designs for piston light aircraft.

• **D. Napier & Son:** Production of *Eland* propeller turbine and shaft turbine (for the Convair 540 and the Westland *Westminster*), also large-scale production of the *Gazelle* gas turbine, several hundred of which have been ordered for a variety of helicopter types; *Spraymat* de-icing system.

• **A. V. Roe** (Hawker Siddeley Group): Production of the *Vulcan Mk. 2,* in squadron service since earlier this year; flight testing and preparation for production of the Avro 748 short-haul airliner (two *Darts*); development of an all-freight version of the 748; project for the Avro 761/771 jet airliner with bypass engines; production and further development of the *Blue Steel* air-to-surface missile for the second generation "V" bombers.

• **Scottish Aviation:** Production of the *Twin Pioneer* multi-purpose STOL transport (two Alvis *Leonides* or Pratt & Whitney R-1340s).

• **Short Brothers & Harland:** Production of the *Canberra;* advanced development of the SC.1 VTOL aircraft (five RB.108s) and project work on various VTOL strike aircraft and day fighters based on this concept; construction of jigs for the RAF's *Britannic* heavy transport; production of the *Seacat* ship-based anti-aircraft rocket and development of a sister weapon, the *Tigercat,* for the land forces; project for the SC.7 feeder airliner.



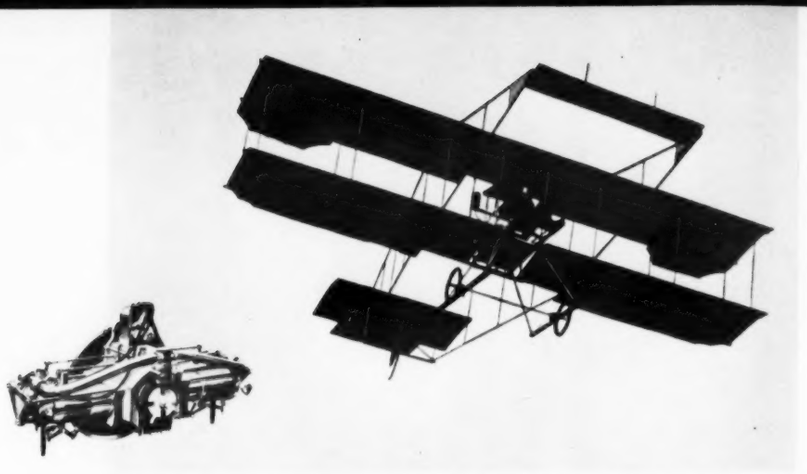
The Napier *Gazelle* 1,260/2,000 e.h.p. shaft turbine on the test bed. The engine is fitted, for example, in the *Wessex* and *Belvedere* helicopters.

• **Westland Aircraft:** Having taken over three other helicopter divisions, Westland is now Europe's and probably the world's biggest rotorcraft manufacturer and is developing and building no fewer than twelve basic types, many of them in several different versions. Seven of these types will be displayed at Farnborough: 1. *Turmo Skeeter* (one Turmo 603); 2. P.531 *Wasp* (one Blackburn *Nimbus* or DH. *Gnome*); 3. *Gnome Whirlwind* (one DH. *Gnome*); 4. *Wessex* (one Napier *Gazelle*); 5. *Belvedere* (formerly known as Type 192; two Napier *Gazelles*); 6. *Westminster* (two Napier *Elands*); 7. *Rotodyne* (two Napier *Elands*; later R.-R. *Tynes*). The company's other products, in particular the *Rotocycle, Sycamore, Widgeon, Whirlwind* and (soon) *Wiltshire* (S-61) and the projected SR-N2 hovercraft for 68 passengers, will probably be on show on Westland's stand in the big exhibition tent.

*

To sum up, no observant visitor to the British aircraft industry this year can miss the new spirit of optimism and purposefulness which is everywhere apparent. We have heard much, over the past two or three years, of hesitations among industry ranks, uncertainties of what the future might hold, even feelings of frustration at Government indecision. From all these reports one almost gained the impression that the whole industry was in the doldrums. But a new wind has arisen. The Government's pressure for a tighter organization, with fewer groups of financially strong companies competing for the limited orders available, has led to a new determination among all ranks in the industry to maintain Britain's position in the aviation world. Full steam ahead, to a known goal, is now the order of the day. ←←

The first Westland *Wessex* anti-submarine helicopters (one Napier *Gazelle* shaft turbine) have been in service with the Royal Navy since April 1960.



In 1908, at the age of 26, Geoffrey de Havilland built his first aircraft, which fell to pieces when he attempted to fly it. His first "hop" was made in his second aircraft (above) on September 10th, 1910. He also designed the engine himself (left).

Fifty Years

of de Havilland Flights

Fifty years later: The *Comet 4C*, latest design of the de Havilland Aircraft Company.

On a peaceful September evening in 1910, a wire-and-canvas biplane made its first "hop" from a tiny meadow on the North Hampshire downs. Its designer, builder and pilot was a young man, Geoffrey de Havilland, whose initials were to make British aircraft designs renowned throughout the world.

When Sir Geoffrey de Havilland celebrates his golden jubilee as pilot and aircraft designer on September 10th, 1960, he has his grandfather to thank for it. When the young mechanical engineer, inspired by exploits of the Wright Brothers and the Frenchmen Blériot and Farman, decided to build an aeroplane in 1908, it was not enthusiasm that he lacked, but financial resources. His grandfather listened to his problems with a sympathetic ear and offered him £1,000—as an advance on the legacy. A friend, Frank Hearle, helped him build the airframe, and the designer's young wife sewed the fabric panels together. The engine, too, was designed by de Havilland and built for him by the Iris Motor Company. On its first attempt to fly, the aircraft fell to pieces, but de Havilland's confidence remained unshattered. The two friends rigged up a new airframe around the engine, which had remained intact. And on a September day in 1910 de Havilland took his seat at the controls—and flew.

The £1,000 had by now run out, and de Havilland took a post as designer and test pilot with the Army Balloon Factory, which bought his aircraft for £400. In the spring of 1914 de Havilland accepted an offer from Holt Thomas and became Chief Designer with the latter's Aircraft Manufacturing Company in Hendon. Here the first "DH." aircraft, the DH.1 and DH.2, took shape. Two years later the DH.4 was built. Thanks to its "high" wing loading—7.8 lb/sq.ft.—and its 325 h.p. Rolls-Royce *Eagle* engine, it achieved an exceptional performance for those days: 110 knots speed; 23,000 ft ceiling. The DH.9, derived from the DH.4, was powered by a Siddeley *Puma* engine, designed by Major Frank Halford, later Chairman and Technical Director of the de Havilland Engine Company.

By the end of the war Airco was building 300 aircraft a month. This boom period was followed by the big slump; in 1920 Airco closed down for lack of orders and was sold to B.S.A. Nothing daunted, Geoffrey de Havilland

The DH.4, a fast multi-purpose two-seat combat aircraft. About 4,800 were built during World War I, over half in the USA. Picture shows the version powered by Rolls-Royce engine (360 h.p.).

KLM opened its Amsterdam–London service with a DH.16 in May, 1920. Far right, Dr. Albert Plesman, founder of KLM and President until his death in 1953.

The two-seat *Tiger Moth* came out in 1932 and won international fame as a trainer. It was the RAF's standard trainer in World War II. Over 8,500 *Tiger Moths* were built in Britain, Canada, Australia and New Zealand, and many are still in operation.

The de Havilland Company developed the DH.88 *Comet* in a few months for the London–Melbourne air race in 1934. In foreground, two *Comets* before take-off. In the third *Comet* (not shown in picture) the winners, C. Scott and T. C. Black, covered the 11,500 mile stretch in 70 hours 54 minutes.

founded the de Havilland Aircraft Company, with £1,875 capital, on September 25th, 1920. Contracts for new aircraft were few and far between, and the company kept going with reconditioning work, aircraft hire and repairs to wind-driven fuel pumps. Gradually, however, a number of airliners came into being: the DH.18, the DH.29, the DH.34 and finally the DH.50, which won fame with Alan Cobham's long-distance flights. For a light aircraft competition Frank Halford halved a V-8 engine to form the 60 h.p. *Cirrus* light engine, and de Havilland provided the airframe. The *Moth* was born. It was just what the flying clubs wanted: simple, inexpensive, easy to fly. The aircraft set many records, proving its reliability in sensational long-distance flights. Production could barely keep pace with orders; branch factories were built in Australia (1927) and Canada (1928). There followed a whole series of derivatives, including the *Tiger Moth* trainer, which reached the highest production figure of all DH. aircraft—8,500—and was sold to 25 countries in five continents. More airliners were developed: the DH.66 *Hercules* for Imperial Airways' Indian route in 1926; the DH.84 *Dragon* in 1933; the DH.86 and DH.89 *Dragon Rapide* in 1934; the DH.91 *Albatross* in 1937; and finally the DH.95 *Flamingo* in 1939.

In World War II the twin-engine DH.98 *Mosquito* was one of the Allies' most versatile aircraft. It served as long-range bomber, day and night fighter, photographic reconnaissance aircraft, and anti-submarine and naval strike aircraft. During the war Major Halford developed the *Goblin*, the first British jet engine to go into quantity production. For this engine the de Havilland works built the DH.100 *Vampire*, of which several derivatives were developed. On December 3rd, 1945, a *Sea Vampire* was the first jet aircraft to land on an aircraft carrier; and in September, 1948, a tailless version, the DH.108, was the first British aircraft to break the sound barrier.

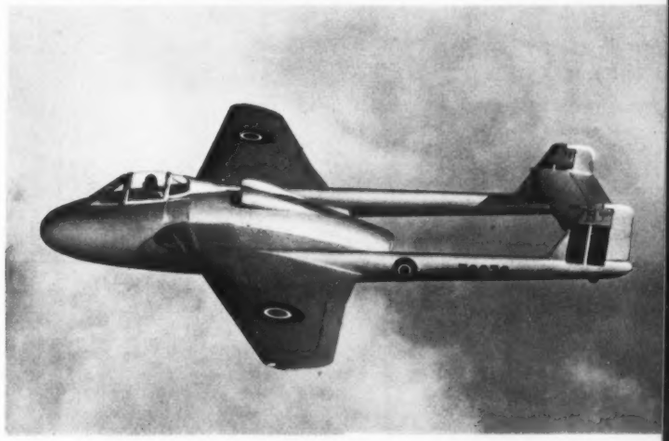
Encouraged by the success of the *Vampire*, de Havilland set to work to develop a jet-powered airliner; and on May 2nd, 1952, BOAC began jet operations with the *Comet 1*. ←

Designed for Qantas's England–Australia route in 1934, the DH.86, with 12-passenger layout, reached cruising speeds of over 125 knots; de Havilland sold 62 aircraft of this type.

Among the most tried and trusted aircraft of the Allies during World War II was the DH.98 *Mosquito*. With a production figure of 7,781, the *Mosquito* was built in almost as large numbers as the *Tiger Moth*.

Alan Cobham (left) aroused world-wide interest with his long-distance flights in a DH.50. England–Cape Town–England in November, 1925, England–Australia–England six months later. Cobham was later knighted for his exploits.

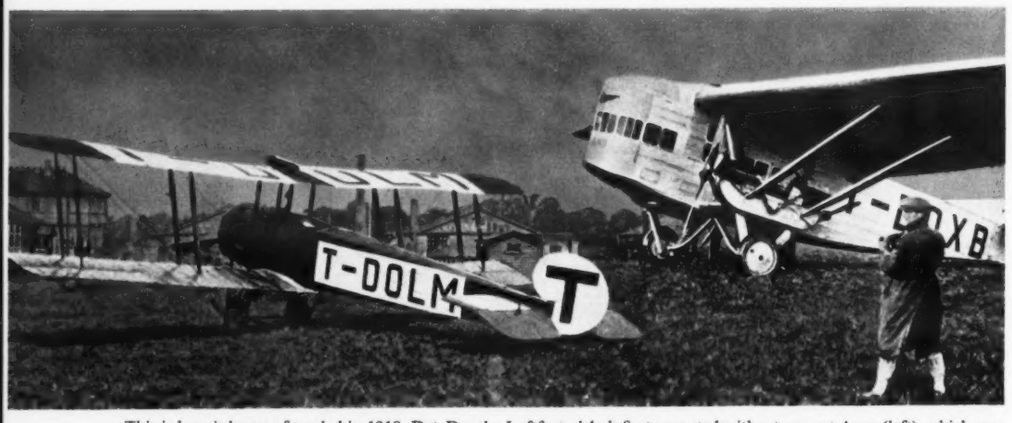
The DH. *Vampire* was supplied to the air forces of more than 20 nations. Picture shows an experimental model, powered by the Rolls-Royce *Nene*.



Stockholm's younger generation enthusiastically greets the arrival of a *Caravelle* at Bromma Airport.

The Nordic Triad in Air Transport

Scandinavian Airlines System



This is how it began: founded in 1918, Det Danske Luftfartselskab first operated with a two-seat Avro (left), which was later followed by a four-engine Farman *Jabiru* with the remarkable speed of 110 m.p.h.

Still an "exhibit" in this picture, the Douglas DC-8 is now in scheduled service with SAS.

When the 16th IATA Annual General Meeting assembles in Copenhagen in September 1960, it will find itself on some of the very oldest IATA territory. Of the five airlines which signed the charter of the original International Air Traffic Association, no less than three were from the Scandinavian countries of Denmark, Norway and Sweden. And one of these companies still bears its old name of Det Danske Luftfartselskab.

It would, however, be quite erroneous to suppose that the Scandinavian air transport industry had grown hoary with age. On the contrary, the Scandinavians have always shown themselves willing to accept reasonable organizational changes and have led the way to international cooperation. If they had not possessed this highly-developed sense of the value of mutual assistance, then Det Danske Luftfartselskab (DDL), Det Norske Luftfartselskap (DNL) and Sweden's A.B. Aerotransport (ABA) might still be respectable regional organizations, but there would be no SAS, Scandinavian passenger volume would not have climbed during the last decade from 480,000 to 1,640,000, and the three nordic countries – with a total population of only 15 million – would not hold their present position among the world's airlines.

At the same time it must also be admitted that the will to cooperate was greatly strengthened by the experience of World War II. True, the Scandinavian carriers had initiated talks back in 1938 on the possibility of pooling their planned North Atlantic services, and a special committee had been set up in Oslo to investigate how the Scandinavia–New York route could be operated on a common basis. But the talks dragged on. All the participants took their time in thoroughly weighing the pros and cons of the plan . . . until they were overtaken by the lightning events of the spring of 1940, which put a temporary end to Danish and Norwegian air transport operations. Only the Swedes remained active. Even they could

fly only within specific limits (Berlin, Helsinki, Moscow, Aberdeen), but they did remain in a position to negotiate.

And neutral Sweden began preparing not only its own post-war future, but also that of its nordic partners. A Swedish intercontinental airline (SILA), founded at this time but later taken over by ABA, ordered ten DC-4s from Douglas, and the Danish Government succeeded, through the intermediary of the Danish National Bank, in making a contribution to the cost of this fleet. At the same time Sweden and the exiled Norwegian Government entered into air transport negotiations with the United States. Interestingly enough, Pan American's President Juan T. Trippe had also sent out feelers towards Scandinavia early in the war, and for a time it looked as if the four companies might get together to run Atlantic services as a joint operation. However, the project—which might well have entirely changed the face of both Atlantic and European air transport—eventually came to nothing. Yet the Scandinavians held on persistently to their desire to cooperate among themselves and to reach out across the Big Pond as soon as possible.

In 1944 the United States Government handed over to the Swedes free of charge five Boeing B-17 bombers which had made emergency landings in Sweden. Suitably converted, these aircraft were used for crew training, for services to Scotland and for first experimental flights to North America.

Once the war was over, the Scandinavians could take steps to put their plans into practice. Despite all preparations, however, the birth was not an easy one. The negotiators sat together a full 18 hours in Oslo's Grand Hotel before the agreement setting up *Scandinavian Airlines System* was signed at four o'clock in the morning on August 1st, 1946.

Incidentally, it speaks highly for the down-to-earth common sense of the Scandinavians that they advanced step by step, leaving the three individual companies their independence and initially submitting only their overseas operations to joint control, which was exercised by a committee of six. Shares in the common operations were divided in the proportion of 3/7 for Sweden and 2/7 each for Denmark and Norway, a ratio which has been retained to this day.

The first Chairman of SAS was the late Per Kampmann, a Dane who had escaped to Sweden during the confusion of war and, together with his Swedish and Norwegian colleagues, Per A. Norlin and Riiser Larsen, had been particularly active in promoting closer ties between the three airlines.

On September 17th, 1946, the first Douglas DC-6 with the SAS triple-flag emblem took off for New York.

•

The past 14 years have proved that the founders of SAS were right. They have also repeatedly shown that the Scandinavian air transport plan-

On the Eve of Copenhagen

By Åke Rusck,
President, Scandinavian Airlines System
and President-Elect,
International Air Transport Association

The airline industry finds itself, for the first time, in a position to evaluate realistically the impact which the coming of the jets has had on international civil aviation. There is no doubt that this evaluation—which will define the shape of things to come in the industry—will be a primary concern of the General Meeting of IATA in Copenhagen.

The development of jet traffic has been extraordinarily swift. At the end of 1958, only two airlines were operating jets across the North Atlantic. A year later, 15 companies had jet transports in service all over the world. By mid-1960, 35 airlines had taken the step into the jet age.

The evolution is even more remarkable when one considers the capacity of the jets. The jetliners in service at the end of last year represented only 2½ percent of the total fleet, but 10 percent of the total capacity. Today, the jetliners account for more than 50 percent of the airlines' aggregate capacity, and next year the figure is expected to rise to 75 to 80 percent.

What we are witnessing, and participating in, is in fact a revolution in air transportation. However, like all revolutions, it will be of short duration; by the end of 1962 the great majority of the jetliners now on order will have been delivered.

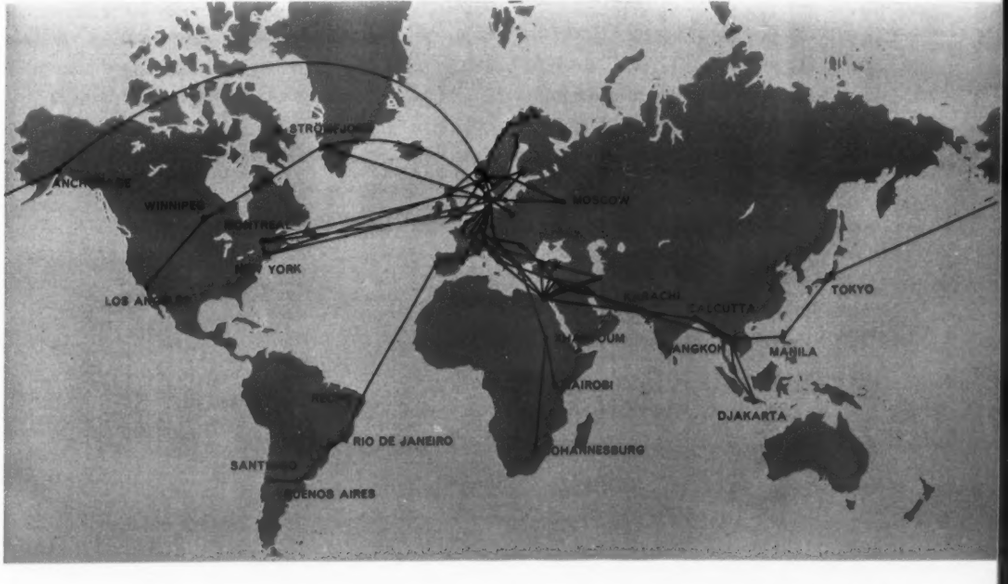
The transition to jet operations certainly has not been devoid of problems, and none of us are immune from them. Yet, when these problems beset us it should, and must, be remembered that the arrival of the jet age has opened the door for the airline industry to achieve its fullest expression in terms of both speed and capacity.

I believe that the industry as such is facing its financial and readjustment problems squarely. I think, furthermore, that it is a tribute to the industry that the airlines holding membership in IATA are able to resolve their major difficulties and disagreements, when they occur, through direct negotiations between themselves, while at the same time retaining a healthy competitive atmosphere.

It has been said that the vast increase in capacity represented by the introduction of the jets will confront the industry with grave problems in selling the available space.

This may be so. Still this is a healthy problem to have to tackle; it represents a vigorous challenge that must be met with resourcefulness and enterprise. As long as we can offer ample space for passengers and cargo, it will continue to be a buyer's market. We are keeping ahead of, or abreast of, the movement towards mass transportation by air at the lowest possible fares. It is, after all, this movement which we are here to serve.

On its route network of 137,000 statute miles, SAS operates to 83 cities in 41 countries.



The new twenty-storey Royal Hotel in Copenhagen, whose lobby connects with SAS' city offices, will house IATA's 16th Annual General Meeting.

ners, while not sticking to the beaten track, approached each new departure with caution, like a conscientious paterfamilias.

In the spring of 1948 a European division was added to SAS' overseas section, but it was not until the beginning of 1951 that the two divisions were merged to form a single international airline, with 50 percent of the capital provided by the nordic Governments. SAS particularly stresses, however, that despite this State participation it receives no form of State subsidy, but covers all its obligations, including the commitments for the procurement of its jet fleet, through its own efforts.

The advent of the jet age found SAS in a strong position. Having shown a profit for several years previously, it had been able to pay some considerable sums into the depreciation account (42 million crowns in 1956, 57 million in 1957 and 49 million in 1958) and had no difficulty in obtaining loans for its fleet programme.

Meanwhile, the route network had been greatly expanded. Operations to South America had been

inaugurated at the end of 1946, and a Far East service to Thailand, opened in October 1949, was extended to Tokyo two years later. Flights between Copenhagen and Johannesburg began in 1953, and on November 15th, 1954 the DC-6B "Helge Viking" opened the Copenhagen–Greenland–Canada–Los Angeles polar route which had been under careful preparation for the previous seven years. This inaugural flight had been preceded by a flight over the North Pole to Alaska. Finally, at the end of February 1957, another Arctic route, to the Far East, was added, cutting journey time between Copenhagen and Tokyo from 52 to 27 hours.

Welcome as was this time saving, SAS was still not satisfied, but was one of Europe's first airlines to order jet aircraft. At the same time it

Before the opening flight Copenhagen–Los Angeles by the DC-8 "Helge Viking": Prince Axel of Denmark (Deputy Chairman of SAS) takes leave of Scandinavian radio reporter Gunnar Hansen (far right), who decided suddenly to drop his microphone, bounded up the stairs and took part in the trip.

facilitated fleet planning by entering into an intelligent cooperation agreement with Swissair.

Like the consortium agreements governing SAS, the arrangement reached with Swissair on October 6th, 1958 is restricted to practicalities. The two companies avoided taking on commitments they were uncertain of being able to fulfil, wasted no time in high-sounding phrases such as "understanding between the peoples," "trade blocks," or the like, but agreed on joint utilization and maintenance of their jet fleet—Douglas DC-8s, Sud-Aviation *Caravelles* and Convair *Coronados*—and left the possibility of coming to a closer economic partnership to the future. In the meantime, however, they have already begun to coordinate their long-distance timetables, so as to avoid duplication and cut out as much competition between them as possible.

There is no room here to go into all the details of the SAS-Swissair agreement, though some of the more important provisions may be picked out as illustrations. The most interesting point is perhaps that the two partners have left each other a free hand to cancel the aircraft exchange arrangements after a given period. In practice this means that each can dissolve its relationship with the other company if the liaison should no longer suit its purposes. For example, SAS was given the right to take back the four *Caravelles* ceded to Swissair, a right which can be exercised four years after the original transfer. A similar clause was incorporated regarding the two Convair *Coronados* which SAS will receive from Swissair in the spring of 1961.

In addition, maintenance, spares provisioning and personnel training for the *Caravelles* were entrusted to SAS, while Swissair undertook the same commitments for the *Coronados*.

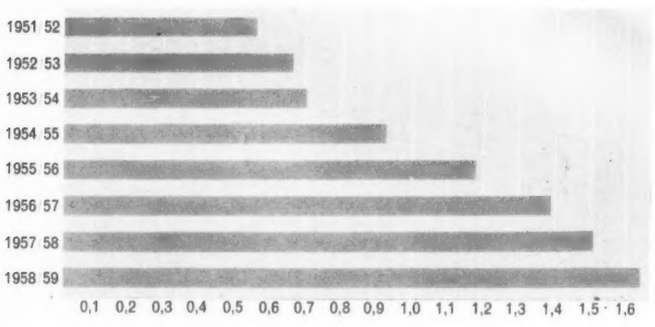
For the DC-8, SAS contributes its training equipment, while as regards spares both partners have joined with other European operators in setting up a pool organization.

In brief, care has been taken to ensure that the two partners shall be hampered as little as possible in their freedom of movement.

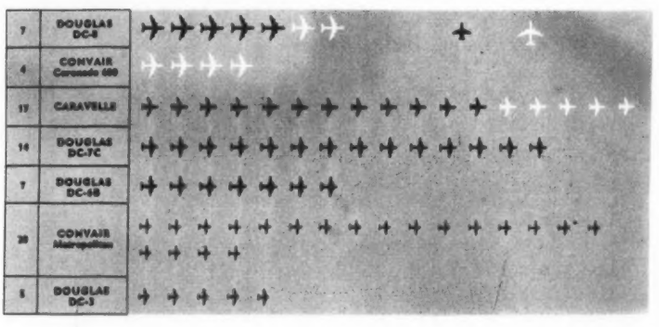
•

When Åke Rusck, President of SAS, takes his place at the head of the International Air Transport Association in mid-September, IATA will have as its President a man whose airline handles the instrument of international cooperation with a master's touch. Any IATA members interested in joining forces could learn much from Scandinavian Airlines System. ⟷

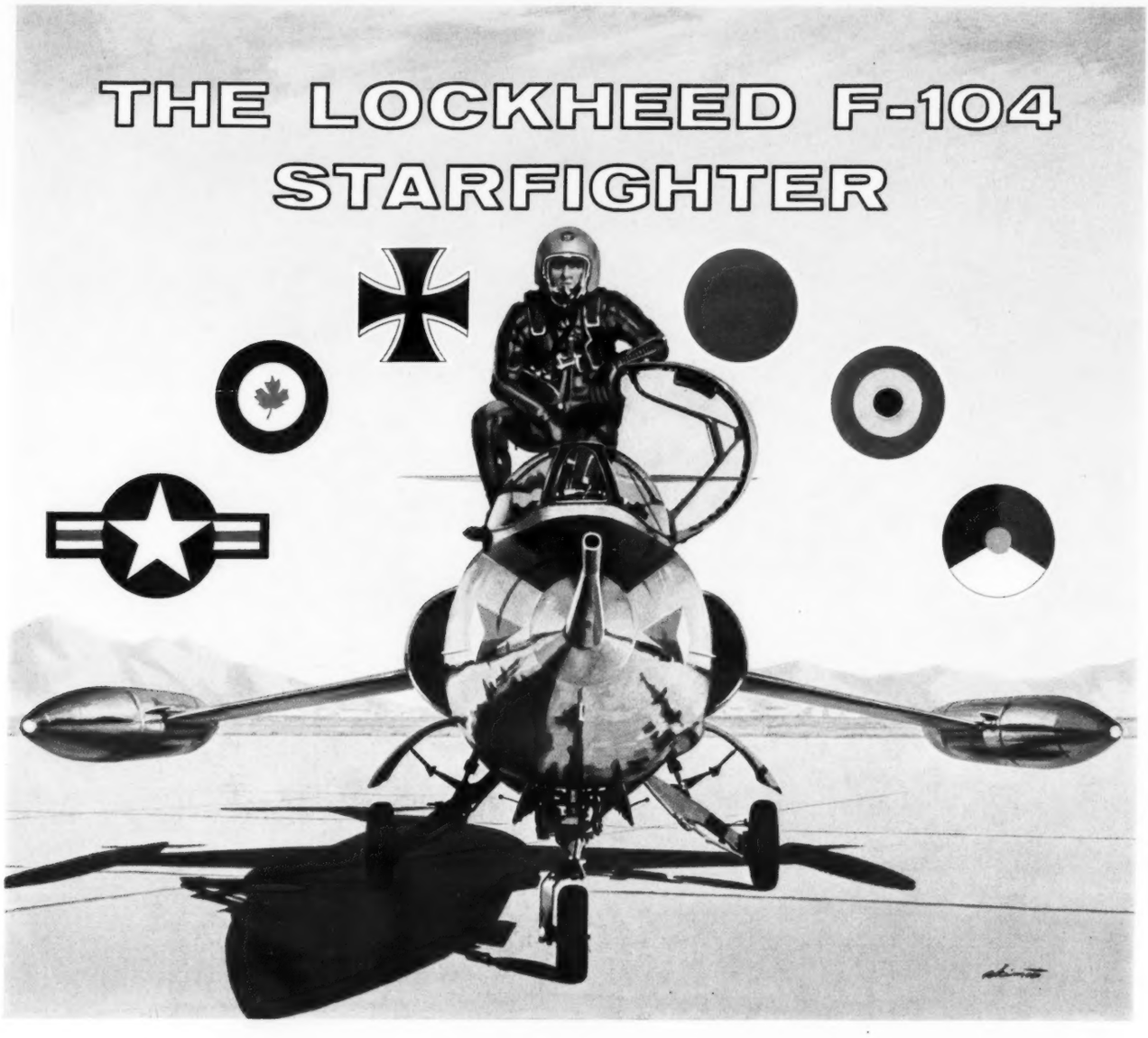
Development of SAS passenger volume from 1950/51 to 1958/59 (in millions).



The SAS fleet: aircraft in service are shown in black, those on order in white. Two Convair *Coronados* will be chartered from Swissair, while SAS will lease four *Caravelles* to Swissair. The five Douglas DC-3s are in service with Linjeflyg, the domestic airline which operates in close collaboration with SAS.



THE LOCKHEED F-104 STARFIGHTER



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G 91 R

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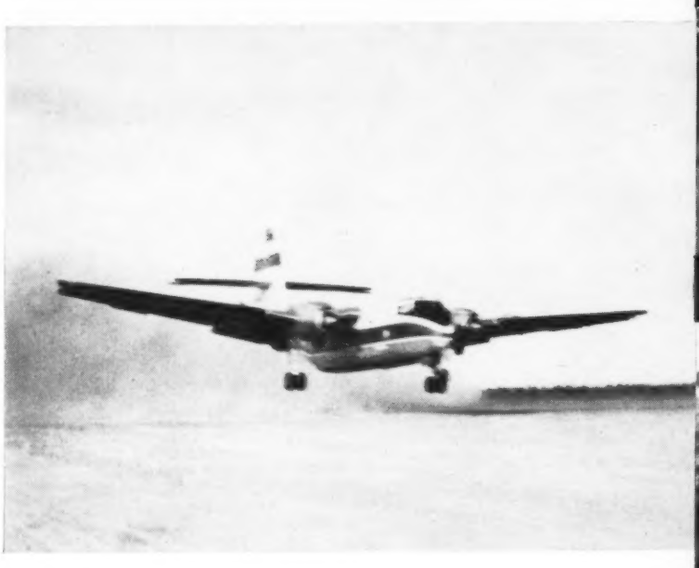

At Mansour and Bahrein Island in the Persian Gulf, the Caribou is seen – in the photo at left centre – taking off from unadulterated desert sand. Photo, lower right, shows depth of furrows ploughed in sand by aircraft's nose wheel gear.

A supreme test of STOL ability was staged at Fort Rucker, Alabama on a mud strip soaked with water for hours, then ploughed to a depth of 14". Photo – upper right – shows mud compacted ahead of wheels. Right centre, deep ruts etched in mud by Caribou take-offs and landings.

The Caribou

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Airview of 1960
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* Not to scale

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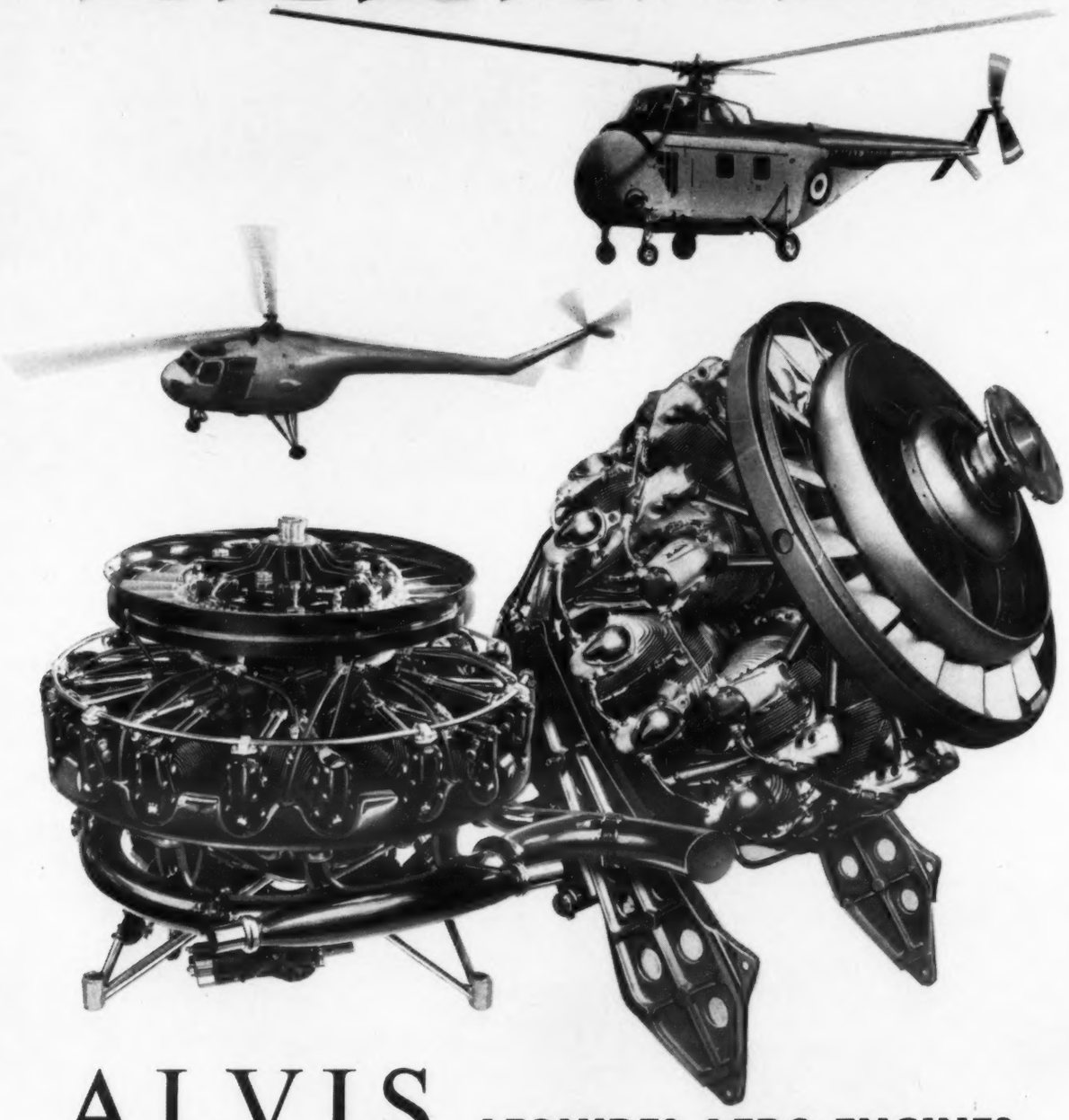

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IATA, Fair and Square

By Derek Dempster, London

No international organization composed of voluntary members backed and supervised by governmental authority can ever hope to work smoothly and avoid the chauvinistic brick-bats that must inevitably be slung its way. The International Air Transport Association is no exception, and in the fourteen years of its existence it has faced and managed to override crises, cat-calls and insults which even the most sober and knowledgeable seriously thought would lead to its complete collapse, at least on the commercial conference level.

The most recent, and perhaps strongest, demonstration of this ability to come through storms was shown at the March, 1960, Paris Traffic Conference—a carry-over of the abortive Honolulu sessions of last October—which succeeded in averting not only the threatened disintegration of world fare structures but also the potential disintegration of IATA as we know it today.

If this willingness to compromise is to be the keynote of future traffic conferences—and there is still enough to be settled to require quite a few more—then air travel may indeed be coming down to the level of the customer it needs to fill its growing fleets of big jets—the man in the street.

Although there was cause for disappointment, the Paris resolutions were less unpopular than most, and an assessment of the Honolulu-Paris achievements should include these plusses:—

1. Extension of economy class across the mid-Atlantic for the first time.
2. Extension of economy class from Europe to the Far East and Australasia for the first time.
3. Extension of economy class from Europe to Africa for the first time.
4. Setting the stage for uniform world-wide standards in jet configuration for the first time.
5. Placing the world fare structure on a two-tier basis.

It was, indeed, an achievement on its own to simplify the fare structure to such a degree that even the travelling public could understand it.

It should not be imagined, however, that the Paris meeting originated the idea of the two-fare structure and pushed it through in the three weeks the conference lasted. On the first day of the unsuccessful Honolulu meeting, a show of hands indicated that the delegates, with only one exception, favoured its reintroduction on a world-wide basis.

It is in fact because of these exceptions—the tenaciously held minority opinions—that the implementation of new policy has been held up in the past, and although they are likely to slow down future progress, the heart-searching occasioned by the possibility of an "open rate" situation developing on many of the world's vital routes after the Honolulu breakdown had a cautionary effect.

This, of course, begs the question: Are open rates possible? The quick answer is a categorical YES: but not without cumbersome and costly penalties!

To begin with, it would be impossible to do away with the basic requirement for bilateral agreements between States, so that one would be left with no alternative than to continue under already established agreements. But since this could only lead to stagnation, governmental intervention would sooner or later become inevitable.

Negotiations between two States would present comparatively few difficulties, but the very nature of progressive air transport demands far wider operating scope, so that the interests of more than a dozen different States would inevitably be involved, in which case no alternative would be left than to call a multilateral meeting of governments! So we're back where we started, conducting international fares and rates conferences, but now with the negotiating States at the tables instead of the airlines!

On the face of it, this exchange of negotiators makes little difference, but a cursory glance at the history of any government will reveal that where State-to-State negotiations are concerned, progress is hampered rather than eased for no more frustrating reason than political, diplomatic and prestige considerations.

The fear of incurring economic penalties such a switch would undoubtedly trail in its wake appears to be further reflected in the Amsterdam decision of the airlines involved in the South American "illegal discount war" to withdraw their protests against the proposed fines imposed on each of them and to submit to discipline.

By and large, then, events at Honolulu and Amsterdam, far from weakening IATA, have served to strengthen its hand, so that it now stands better equipped than ever before to deal with breaches of discipline still rife in South America and the Middle East. Politics, in turn, are kept in the back seat at the conference tables, forming a traditional backcloth to negotiations.

But even today that backcloth is far too vivid for the good of the air transport business.

As the Association has itself explained, the airlines do not necessarily belong to IATA because they want to belong. "They are in it because their governments insist that international fares and rates should be agreed on a government level and that the airlines must have a voice in framing them."

Why governments "insist upon having the final say on fares may differ from country to country," but in a nutshell the principal reasons are to "protect the user against exploitation; to ensure that standards of safe operation will not be sacrificed to price cutting; to avoid the need for undue subsidies, and to protect the existence of their own flag carriers on whom they may depend for communications essential to their commercial and strategic existence. This is, of course, a legitimate exercise of national sovereignty; and since few, if any, governments have been willing to relinquish any degree of sovereignty to any supra-national organization, these fares and rate agreements must be worked out by negotiation."

The airlines can start negotiations, therefore, only after equating their own views with those of their governments, and since the views of the latter are in many cases framed by emotional reactions dictated

by national pride, the dice are nearly always heavily loaded against expeditious progress. The man in the street is only too eager to give the airlines his custom, but only if they will help him to give it!

And so, air transport hobbles on, beset by the differences of the "haves" and the "have nots," the rich and the not so rich, the giants and the midgets.

Allowing for the fact that the airlines are never averse to the old commercial practice of placing the competitor at a disadvantage, political considerations are becoming too firmly entrenched for the good of civil aviation. Given greater freedom to negotiate on purely commercial and technical grounds, without political coercion, the airlines would undoubtedly make much faster progress than they are likely to make for the time being.

The point I have been trying to make is that air transport is bedevilled by politics, and when you consider the International Air Transport Association, you cannot help but recall the words of a London headmaster who complained about the irresponsibilities of modern youth. "They gang up together," he said acidly, "and lie endlessly when they are caught. If you prohibit or take action against these things, you run the risk of being termed a square." Of course, he said bravely, "I am content to be called a square."

A square, in the idiom of modern youth, is simply a misfit, a spoilsport, a non-conformist, a disciplinarian; but then schoolmasters have always been squares—the alien governors of rebellious provinces surrounded by networks of spies and agitators conducting endless propaganda wars against the agents of anarchy, unrest and intrigue.

Boys will be boys—that is, thieves, bullies, scoundrels, schemers and hirelings of Satan; and masters, of course, will be masters—or dictators, snobs, prigs, bores and servants of the Occupying Power.

When he took over the headmastership of Rugby School in 1828, Dr Thomas Arnold, the inventor of the modern British public school, commented: "My object will be, if possible, to form Christian men. For Christian boys I can scarcely hope to make."

This analogy is not so very far-fetched when you consider the Association. IATA is like a school; an organization administered by people properly appointed by the governing parents—the member States—to mould and educate its pupils—the member airlines—into a disciplined and cooperative body doing unto others as they would be done by. But human nature being what it is, IATA can scarcely hope to achieve such lofty ideals, for parents can be bullies, scoundrels, schemers and hirelings of Satan just as much as their offspring. Besides, since when, in the history of man has an organization composed of voluntary members been able to march in step at all times?

IATA can be only as perfect as its members. But like the school, it has the important task of directing the airlines towards the acceptance of effective, efficient world standards. In its attempts, however, someone, somewhere is always bound to regard it as a square.

Pillars of World Air Transport

A "Who's Who" of the International Air Transport Association

(as at the beginning of September, 1960)

The fact that the number of IATA members has hardly changed since the 1959 Annual General Meeting—89 this year against 90 last year—is by no means a sign that the Association has lost its powers of attraction, but merely that Sir William Hildred at last appears to have succeeded in gathering a full brood of airlines under his organization's wing.

As before, the number of active members, i.e., those who run international services, remains at 80: the British companies Airwork Ltd. and Hunting Clan Air Transport Ltd. have merged to form British United Airways Ltd., which commands an impressive fleet of 48 fixed-wing aircraft and 47 helicopters. This "loss" of an active member has been made up for by a new arrival, the Argentine carrier Aerolíneas Ini y Cia S.A., of Buenos Aires. Of the 10 associate members of 1959, Trans Caribbean Airways has left the Association.

*

On September 12th, delegates from the IATA companies will meet in Copenhagen to review the situation of the world's scheduled air transport in five days of discussions and lay down the bases for its further extension in the year 1960/61.

Although the final operating statistics for 1959 were not available at the time these lines went to print, there is reason to believe that world air transport can look back on its achievements with some degree of satisfaction. Some months ago Sir William Hildred, IATA's Director General, expressed the belief that the year 1960 would see the passenger figure rise above 100 million for the first time, and in the light of the last two years' results (87 million in 1958 and 95 million in 1959) this seems highly probable—the more so as the increase in jet traffic is proceeding at an unslackened pace. To take but one example, the IATA companies operating across the North Atlantic recorded a 19.2 percent passenger increase for 1959, and during the first quarter of 1960, namely in the "dead season," an increase of 19.5 percent above the corresponding period in the previous year.

As an organization, too, IATA recorded gratifying progress during 1959. There was, of course, the success of the Paris tariff conference, to which the previous article is devoted, but yet another telling example of administrative development is in the results of the IATA Clearing House, whose services were used by 73 companies at the beginning of 1960, against 67 at the beginning of 1959. In 1959 the Clearing House reported a turnover of £361 million without the need for cash payments, as compared with £292 million in 1958. In other words, the amount cleared daily is almost one million pounds.

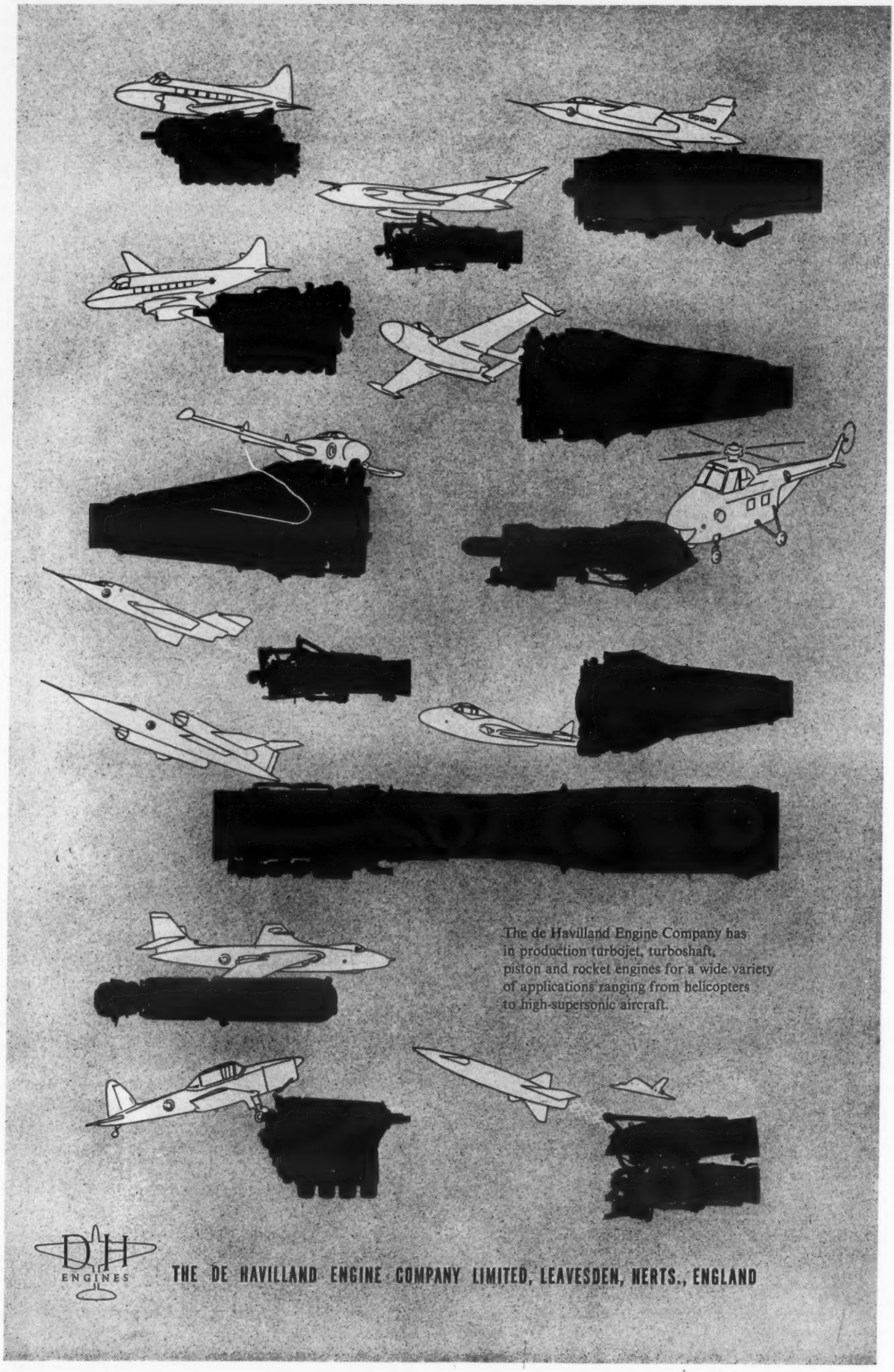
*

There has been no basic change in the arrangement of the table. The column "Capital" has again been included, with an indication of the extent of the State holding. In view of the increasing significance of air freight operations, the number of freight ton-miles has been included in the operating statistics column.

PILLARS OF WORLD AIR TRANSPORT

a) *Capital in U.S.* $ (millions) b) *State holding*	MANAGEMENT	AIR FLEET Available	AIR FLEET On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route mileage* (unduplicated) b) *Employees*
EUROPE						
AER LINGUS (IRISH INTERNATIONAL AIRLINES), 43, Upper O'Connell Street, Dublin, Ireland.						
a) 8.6 b) 97%	Patrick Lynch, Chairman J. F. Dempsey, General Manager Captain J. C. Kelly-Rogers, Deputy General Manager James Gorman, Asst. General Manager P.J. Brennan, Secretary	7 Fokker F.27 7 Vickers Viscount 5 Douglas DC-3	—	Dublin to 12 points in Europe, 13 points in Britain; Dublin-Shannon	a) 522 b) 11,705 c) 1,583	a) 8,755 b) 1,962
AERLINTE EIREANN (IRISH INTERNATIONAL AIRLINES), 43, Upper O'Connell Street, Dublin, Ireland.						
a) 7.7 b) 100%	John Leydon, Chairman J. F. Dempsey, General Manager Captain J. C. Kelly-Rogers, Deputy General Manager James Gorman, Asst. General Manager P. J. Brennan, Secretary	3 Lockheed 1049 (leased)	3 Boeing 707	Dublin to New York and Boston	a) 21 b) 6,153 c) 197	a) 3,073 b) 112 (N.B. Aer Lingus staff also act on behalf of Aerlinte Eireann)
AIR FRANCE, Compagnie Nationale, Rue Marbeuf 2, Paris 8e, France.						
a) 20 b) 70%	Max Hymans, Chairman Louis Lesieux, President & General Manager Maurice Lemoine, V.P. & Secretary General Raymond Dupré, V.P. — Technical Robert Montarnal, V.P. — Economic Affairs	8 Boeing 707 15 Sud-Aviation Caravelle 22 Lockheed 749/1049 8 Vickers Viscount 12 Breguet Provence 56 Douglas DC-3/4	9 Boeing 707 12 Sud-Aviation Caravelle	Paris to N. & S. America, Caribbean, Africa, Near & Far East, European capitals & cities; local services in Africa; domestic mail services	a) 2,781 b) 2,267,697 c) 55,628	a) 193,000 b) 20,913
ALITALIA, Viale Maresciallo Pilsudski 92, Rome, Italy.						
a) 40 b) 88.76%	Count Nicolò Carandini, President General Aldo Urbani, V.P. Bruno Velani, Managing Director Donato Saracino, Deputy Managing Director Renato Cappelletti, Commercial Manager	3 Douglas DC-8 5 Douglas DC-7C 11 Douglas DC-6/6B 4 Douglas DC-3 4 Sud-Aviation Caravelle 9 Vickers Viscount 6 Convair 440	3 Douglas DC-8	North and South America, North, South, East and Central Africa, Near East, Europe; India & Pakistan; domestic	a) 850 b) 645,851 c) 8,523	a) 71,307 b) 4,726
AUSTRIAN AIRLINES, Salesianergasse 1, Vienna III, Austria.						
a) 2.4 (shortly to be increased) b) n.a.	Dr. Josef Koller, Chairman Felix A. Schalk, Commercial Manager Dr. Heinrich Kreissler Flight Captain Alexander Raab	6 Vickers Viscount	—	Vienna to 17 points in Europe and Middle East; domestic	a) 73 b) 2,537 c) 198	a) 8,700 b) 365
AVIACIÓN Y COMERCIO S.A., Aduana 33, Madrid, Spain.						
a) 2.5 b) n.a.	Jesús Rubio López, Vice-President Emilio Gil Cacho, General Manager José Inchausti, Deputy Manager, Administration Carlos Texidor, Deputy Manager, Traffic Francisco MacLennan, Commercial Manager	3 Convair 440 3 Bristol 170 10 others	—	Domestic; to points in N. Africa, Marseilles, Brussels	a) n.a. b) 32,566 c) n.a.	a) 9,266 b) 441
BRITISH EUROPEAN AIRWAYS, Keyline House, South Ruislip, Middlesex, England.						
a) n.a. b) 100%	Marshal of the Royal Air Force Lord Douglas of Kirtleside, Chairman Sir John Keeling, Deputy Chairman Anthony H. Milward, Chief Executive	7 D.H. Comet 4B 62 Vickers Viscount 29 Douglas DC-3 4 others 3 helicopters	20 Vickers Vanguard 3 D.H. Comet 4B 24 D.H. 121	London to 76 points in Europe & Middle East; domestic	a) 3,290 b) 1,153,785 c) 14,894	a) 31,274 b) 12,170
BRITISH OVERSEAS AIRWAYS CORPORATION, London Airport, Hounslow, Middlesex, England.						
a) 384.7 b) 91%	Sir Matthew Slattery, Chairman Sir Wilfred Neden, Deputy Chairman Basil Smallpeice, Managing Director K. H. Staple, Secretary & Legal Adviser	6 Boeing 707 19 D.H. Comet 4 32 Bristol Britannia 10 Douglas DC-7C	9 Boeing 707 35 Vickers VC.10	To points in Europe, Africa, N. America, Central America & Caribbean, Asia, Australasia	a) 561 b) 1,761,274 c) 37,718	a) 105,255 b) 19,004
BRITISH UNITED AIRWAYS LTD., 35, Piccadilly, London W.1, England.						
a) n.a. b) —	M.D.N. Wyatt, Chairman F. A. Laker, Executive Director R. L. Cumming, Exec. Dir. & Secretary A. E. Bristow, Executive Director T. W. Morton, Executive Director	4 Bristol Britannia 10 Vickers Viscount 2 Douglas DC-6C 9 Douglas DC-3/4 9 Bristol 170 14 others 47 helicopters	—	London & Southend to points in Europe, & E., W., Central & S. Africa	a) 119 b) 43,661 c) 3,399	a) 26,109 b) 923
C.S.A., CESKOSLOVENSKE AEROLINIE, Namesti Republiky 655/8, Prague 1, Czechoslovakia.						
a) n.a. b) 100%	Josef Procházka, Director General Oldrich Holovský, Technical Director Vaclav Libovický, Operations Director Jaroslav Jechumtál, Commercial Director Vratislav Drábek, Financial Director	4 Tupolev Tu-104A 25 Ilyushin Il-14 2 Ilyushin Il-18	—	Prague to 20 points in E. and W. Europe; to Cairo & Bombay	a) 86 b) 70,357 c) 1,708	a) 12,560 b) 1,959
* **CYPRUS AIRWAYS LTD.,** 16, Byron Avenue, Nicosia, Cyprus.						
a) n.a. b) n.a.	Dr. C. Raeburn, Chairman P. Holroyd Smith, General Manager	Services operated by BEA Viscount aircraft	—	Near and Middle East; Greece; connections to U.K.	a) n.a. b) n.a. c) n.a.	a) 2,000 b) 190
DEUTSCHE LUFTHANSA AG., Claudiusstrasse 1, Cologne, Germany.						
a) 43 b) 95%	Hans M. Bongers Gerhard Höltje Wolfgang A. Kittel Hans Süssenguth	3 Boeing 707 11 Lockheed 1049/1649 9 Vickers Viscount 9 Convair 440 3 Douglas DC-3	2 Boeing 707 4 Boeing 720B	To U.S. E. & W. coast; South America; to 11 points in Europe; to Near & Far East; domestic	a) 786 b) 523,400 c) 10,400	a) 57,960 b) 7,530
EAGLE AIRWAYS LTD., Marble Arch House Air Terminal, Edgware Road, London W.2, England.						
a) n.a. b) —	H. Bamberg, Chairman & Managing Director M. A. Guinane, Deputy Managing Director J. T. Hutton, Commercial Manager A. J. Lovegrove, Sales Manager	1 Bristol Britannia 3 Douglas DC-6C 11 Vickers Viking	—	London to 9 points in Europe; Manchester to 2 points; Birmingham to Palma	a) 26 b) 14,931 c) 6	a) 5,173 b) 650
FINNAIR AERO O/Y, Töölönkatu 4, Helsinki, Finland.						
a) 2.8 b) 73%	L. Grandell, President B. Aulin, V. P. Technical M. Mannio, V. P.-Traffic & Sales K. J. Temmes, V. P.-Operations H. Soininvaara, Manager-Finances & Economics	3 Sud-Aviation Caravelle 6 Convair 440 9 Douglas DC-3	—	To 13 points in Europe; domestic to 14 points	a) 402 b) 109,029 c) 1.2	a) 10,795 b) 1,184
FLUGFELAG ISLANDS (ICELANDAIR), Reykjavik Airport, Reykjavik, Iceland.						
a) 0.145 b) 14.28%	Orn O. Johnson, General Manager S. Matthiasson, Secretary J. R. Snorrason, Chief Pilot B. Tomasson, Chief Engineer S. Thorbjornsson, Chief Accountant	2 Vickers Viscount 1 Douglas DC-4 3 Douglas DC-3 1 PBY-5A	—	To U.K., Scandinavia and Germany; domestic	a) 67 b) 30,881 c) 489	a) 4,940 b) 240

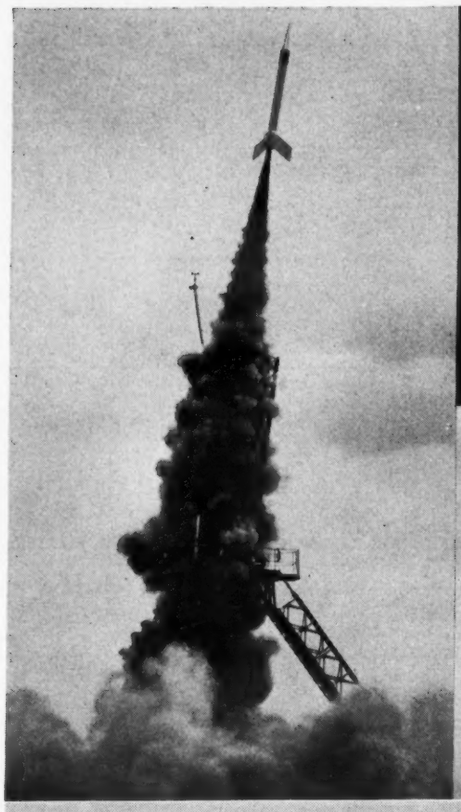
* No information available direct from company: accuracy not guaranteed n.a. = not available.


The de Havilland Engine Company has
in production turbojet, turboshaft,
piston and rocket engines for a wide variety
of applications ranging from helicopters
to high-supersonic aircraft.
DH
ENGINES
THE DE HAVILLAND ENGINE COMPANY LIMITED, LEAVESDEN, HERTS., ENGLAND

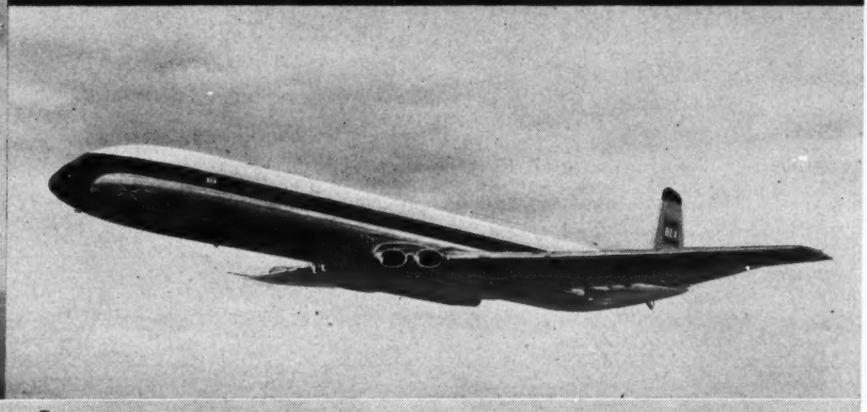
PILLARS OF WORLD AIR TRANSPORT

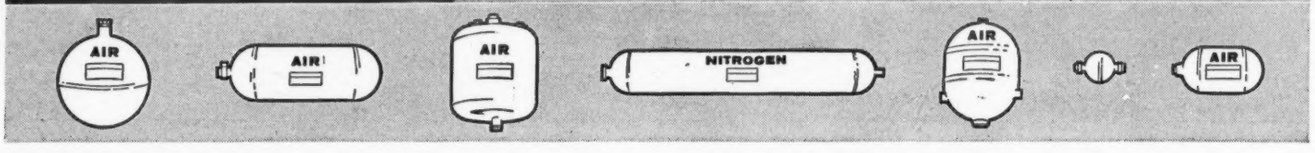
a) *Capital in U.S.$ (millions)* b) *State holding*	MANAGEMENT	AIR FLEET: Available	AIR FLEET: On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route mileage* (unduplicated) b) *Employees*
IBERIA, Líneas Aéreas de España S.A., Avenida de América 2, Madrid, Spain.						
a) 6.0 b) 100%	Tomás Delgado y Pérez de Alba, President César Gómez Lucía, Managing Director Francisco Iglesias Brage, Assistant Manager — Equipment José María Ansaldo Vejarano, Assistant Manager — Traffic Juan Viniegra Velasco, Secretary General	5 Lockheed 1049 7 Convair 440 7 Douglas DC-4 14 Douglas DC-3 4 Bristol 170	3 Douglas DC-8	To New York; points in Latin America; Africa; Europe; domestic	a) 834 b) 382,347 c) 37,279	a) 33,550 b) 3,142
J.A.T., JUGOSLOVENSKI AEROTRANSPORT, Bircaninova 1/III, Belgrade, Yugoslavia.						
a) 6.7 b) 100%	Velimir Terzic, Director General Radmilo Radojkovic, Technical Director Vojislav Rakic, Operational Director Rasko Radojevic, Financial Director Gojko Vojvodic, Commercial Director	1 Douglas DC-6B 3 Convair 340/440 6 Ilyushin Il-14 13 Douglas DC-3	—	To 9 points in Europe, Cairo; domestic	a) 161 b) 48,144 c) 623	a) 7,160 b) 977
K.L.M., ROYAL DUTCH AIRLINES, 1, Plesmanweg, The Hague, Netherlands.						
a) 38.3 b) 69%	I. A. Aler, President E. H. van der Beugel, Deputy President F. Besançon, Executive V. P. J. C. van der Kloot, Executive V. P. L. H. Slotemaker, Executive V. P. J. van der Wiel, Executive V. P.	4 Douglas DC-8 15 Douglas DC-7C 11 Douglas DC-6/6A/6B 13 Douglas DC-3 10 Lockheed Electra 28 Lockheed 749/1049 2 Fokker F.27 9 Vickers Viscount 10 Convair 340	8 Douglas DC-8 2 Lockheed Electra	To N., Central & S. Africa; N., Central & S. America; Asia & Australia; Caribbean; European network	a) 1,104 b) 1,401,700 c) 59,600	a) 168,000 b) 17,332
* **L.O.T.**, Polskie Linie Lotnicze, ul. Hoza, 39, Warsaw, Poland.						
a) n.a. b) 100%	J. Krzywicki, General Manager R. Kuryjanski, Technical Manager A. Wojnowski, Commercial Manager M. Grabowski, Operations Manager	11 Ilyushin Il-14 12 Ilyushin Il-12 20 Livotchkin Li-2 3 Convair 240 5 Douglas DC-3	Ilyushin Il-14P	Domestic; 17 points in Eastern and Western Europe	a) n.a. b) n.a. c) n.a.	a) 8,100 b) n.a.
OLYMPIC AIRWAYS S.A., 6, Othonos Street, Athens, Greece.						
a) n.a. b) —	S. Damaskinos, General Manager J. Papadakis, Sales Manager Ch. Mavrokefalos, Traffic Manager C. Danis, Technical Manager C. Chondros, Operations Manager	3 D.H. Comet 4B 3 Douglas DC-6B 2 Douglas DC-4 13 Douglas DC-3	1 D.H. Comet 4B 2 Douglas DC-8	To 14 points in Europe & Middle East; domestic to 14 points	a) 409 b) 130,177 c) 1,467	a) 8,810 b) 1,570
SABENA, Société Anonyme Belge d'Exploitation de la Navigation Aérienne, Air Terminus, Brussels 1, Belgium.						
a) 15 b) 65 %	Gilbert Périer, Chairman Gaston Claeys, Managing Director W. Deswarte, General Manager Gaston Dieu, Asst. General Manager	5 Boeing 707 8 Douglas DC-7C 13 Douglas DC-6/6A/6B 5 Douglas DC-4 28 Douglas DC-3 9 Convair 440 9 helicopters	4 Sud-Aviation Caravelle	From Brussels to 36 points in Europe and 44 in Africa; North Atlantic and Middle East services	a) 739 b) 747,505 c) 19,941	a) 132,000 b) 10,776
SCANDINAVIAN AIRLINES SYSTEM, Bromma Airport, Stockholm, Sweden.						
a) 30.5 b) 50%	Ake Rusck, President Thore Boye, Executive V. P. — Foreign Relations and Personnel Olof Carlstein, Executive V. P. — Production and Sales Viggo J. Rasmussen, Executive V. P. — Region Denmark Johan Nerdrum, Executive V. P. — Region Norway	5 Douglas DC-8 14 Douglas DC-7C 7 Douglas DC-6B 12 Sud-Aviation Caravelle 20 Convair 440	2 Douglas DC-8 5 Sud-Aviation Caravelle 4 Convair 600	Domestic and inter-Scandinavian routes; points in Europe; North and South Atlantic ; polar routes Europe - Greenland - U.S. West Coast and Europe-Alaska-Japan; Middle and Far East; Africa	a) 1,642 b) 1,181,000 c) 20,720	a) 138,000 b) 12,716
SKYWAYS LTD., 7, Berkeley Street, London, W.1., England.						
a) 0.88 b) —	E. Rylands, Managing Director C. F. Dickson, Director H. P. Snelling, General Manager, Commercial D. J. Davies, Company Secretary R. Birkett, General Manager, Skyways Coach Air Ltd.	4 Lockheed 749 6 H.P. Hermes 7 Avro York 5 Douglas DC-3 3 others	3 Avro 748	London to 7 points in France; Tunis; Malta	a) n.a. b) n.a. c) n.a.	a) n.a. b) 730
SWISSAIR, Swiss Air Transport Company Ltd., Hirschengraben 84, Zurich, Switzerland.						
a) 24.7 b) 30%	Ernst Schmidheiny, Chairman Dr. Walter Berchtold, Managing Director	3 Douglas DC-8 5 Douglas DC-7C 8 Douglas DC-6A/6B 8 Douglas DC-3 4 Sud-Aviation Caravelle 11 Convair 440 1 Pilatus P-3	5 Convair 600	Europe; North and South America; Near and Far East	a) 1,106 b) 56,089 c) 14,733	a) 78,900 b) 6,187
TRANSPORTES AÉREOS PORTUGUESES S.A.R.L., Rua do Conde de Redondo 79, Lisbon, Portugal.						
a) 4.1 b) 16.7%	Alfredo Queiroz Ribeiro Vaz Pinto Carlos Marques Magalhães Duarte Pinto Basto de Gusmão Calheiros Com. Alfredo Luís Soares de Mello Luis Forjaz Trigueiros	3 Lockheed 1049 3 Douglas DC-4	—	Portuguese African provinces; points in Europe and Africa	a) 77 b) 93,739 c) 555	a) 9,033 b) 1,079
TRANSPORTS AÉRIENS INTERCONTINENTAUX, Aéroport d'Orly (Seine-et-Oise), France.						
a) 3.2 b) —	Paul Bernard, Chairman General Georges Fayet, Vice-Chairman J. J. Wilmot-Roussel, General Manager	1 Douglas DC-8 2 Douglas DC-7C 5 Douglas DC-6/6 B 2 Douglas DC-4 1 Douglas DC-3	2 Douglas DC-8	France to West Africa, Morocco, Somaliland, Madagascar; Paris to Los Angeles via Far East; Australasia; Tahiti	a) 79 b) 223,553 c) 4,778	a) 58,777 b) 1,500
TÜRK HAVA YOLLARI A.O., Nesli Han, Galata, Istanbul, Turkey.						
a) 6.6 b) 51%	Staff Colonel Serafettin Kirmizi, Acting General Manager Hüseyin Yegin, Technical Manager Necmi Aran, Commercial Director Suphi Iscen, Operations Manager Turgut Sayar, Accounting Manager	4 Vickers Viscount 21 Douglas DC-3	5 Fokker F.27 5 Fairchild F-27	Domestic; 5 points in Europe and Middle East	a) 368 b) 101,435 c) 793	a) 11,200 b) 1,736
UNION AÉROMARITIME DE TRANSPORT, Boulevard Malesherbes 3, Paris 8e, France.						
a) 1.3 b) —	Louis Pommery, Chairman Jean Combard, Manager Roger Loubry, Manager	1 Douglas DC-8 10 Douglas DC-6B 4 Douglas DC-4 7 D.H. Heron	1 Douglas DC-8	Paris to Nice, Bordeaux, Marseilles; points in Africa, Rhodesia and South Africa; local African services	a) 200 b) 264,421 c) 11,533	a) 59,000 b) 2,800

* No information available direct from company; accuracy not guaranteed n.a. = not available.



MUCH MORE ENERGY IN THE AIR—AND BEYOND





Bristol Aerojet produce gas storage vessels for maximum energy supply with minimum bulk for aircraft and guided missile systems

Bristol Aerojet have developed a very advanced range of gas storage vessels, with an exceptionally high energy/weight ratio, which operate with great reliability. These vessels are particularly suitable for aircraft and guided missile systems *for they pack more energy into less space for less weight than any other type of gas storage vessel.*

Made of chrome molybdenum steel, the vessels are welded by the argon shielded tungsten arc process and heat treated to a minimum ultimate tensile strength of 75 tons per sq in. All vessels are examined several times, both visually and radiographically, to ensure the highest standards of welding. These are only two examples of the many stringent quality controls which are performed during manufacture.

The vessels, which range from 10 to 2,000-cu-in capacity, have been approved for operation under ARB and military conditions. They are made in a very large number of specified shapes: spherical; cylindrical; annular; and toroidal.

Bristol Aerojet pressure vessels show a weight saving of at least 5 lb per 500 cu in and as much as 50% when compared with forged vessels.

Bristol Aerojet pressure vessels have been supplied to many manufacturers of aircraft and guided missiles for a variety of applications, which include the following.

Civil Aircraft	Military Aircraft	Guided Missiles
Bristol Britannia	Details are security destricted	
De Havilland Comet 4		
Vickers Viscount		
Vickers Vanguard		

BRISTOL AEROJET

If you would like further information about Bristol Aerojet pressure vessels or high-tensile steel welded components, please write to:
P. W. LAWSON, CIVIL SALES MANAGER, BRISTOL AEROJET LIMITED, BANWELL, WESTON-SUPER-MARE, ENGLAND. TELEPHONE: BANWELL 250

PILARS OF WORLD AIR TRANSPORT

a) *Capital in U.S.* $ (millions) b) *State holding*	MANAGEMENT	AIR FLEET Available	AIR FLEET On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route mileage* (un-duplicated) b) *Employees*

U.S.A. AND CANADA

AMERICAN AIRLINES, 100, Park Avenue, New York, N.Y.

a) 200 b) —	C. R. Smith, President W. J. Hogan, Executive V. P. O. M. Mosier, Executive V. P. G. A. Spater, Executive V. P. C. W. Jacob, Senior V. P.	3 Boeing 720 25 Boeing 707 24 Lockheed Electra 33 Douglas DC-7/7A 54 Douglas DC-6/6A 44 Convair 240	22 Boeing 720/B 25 Convair 600 10 Lockheed Electra	U.S. transcontinental to 23 States and District of Columbia; Canada and Mexico	a) 8,154 b) 5,736,999 c) 103,195	a) 15,137 b) 23,908

BRANIFF INTERNATIONAL AIRWAYS INC., Exchange Park, Dallas 35, Texas.

a) 77.5 b) —	Chas. E. Beard, President J. W. Miller, Executive Vice President R. V. Carleton, V. P. — Operations Rex Brack, V. P. — Traffic & Sales C. G. Adams, V. P. — Finance & Secretary	4 Boeing 707 8 Lockheed Electra 6 Douglas DC-7C 10 Douglas DC-6 31 Convair 340/440 2 Curtiss C-46	3 Boeing 720	Texas to New York, Chicago, Midwest, Colorado and points in South America	a) 2,160 b) 1,025,685 c) 11,279	a) 14,618 b) 5,382

CANADIAN PACIFIC AIR LINES LTD., Vancouver Airport, British Columbia.

a) 22.75 b) n.a.	G.W.G. McConachie, President R. W. Ryan, Executive Vice-President R. B. Phillips, V. P. — Administration H. B. Renwick, V. P. — Traffic J. C. Gilmer, Comptroller	8 Bristol Britannia 9 Douglas DC-6 12 others	4 Douglas DC-8	To Far East, Australia, South America, Mexico, Europe; domestic	a) 303 b) 457,705 c) 5,467	a) 43,223 b) 2,761

** **CHICAGO HELICOPTER AIRWAYS,** 5240 West 63rd Street, Chicago 38, Illinois.

a) n.a. b) —	John S. Gleason Jr., President & Treasurer C. W. Moore, Executive Vice President John C. Brogan, Vice President — Secretary R. S. Angstadt, Vice President — Operations C. E. Liske, Vice President — Traffic & Sales	8 Sikorsky S-58 4 Bell 47	6 Sikorsky S-61	Local helicopter services	a) 204 b) 819 c) —	a) 394 b) 180

DELTA AIR LINES, INC., Atlanta Airport, Atlanta, Georgia.

a) 37.5 b) —	R. W. Freeman, Chairman C. E. Woolman, President & General Manager Todd G. Cole, Executive V. P. — Administration C. H. Dolson, Executive V. P. — Operations T. M. Miller, V. P. — Traffic & Sales	6 Douglas DC-8 3 Convair 880 20 Douglas DC-7/7B 7 Douglas DC-6 28 Convair 340/440 9 Douglas DC-3 5 Curtiss C-46	9 Convair 880	Domestic, New York, Chicago and Detroit to South & West; to points in Caribbean area, Caracas	a) 3,091 b) 1,616,000 c) 15,725	a) 11,379 b) 7,371

EASTERN AIR LINES, INC., Eastern Air Lines Building, 10, Rockefeller Plaza, New York 20, N.Y.

a) 41.9 b) —	Capt. E. Rickenbacker, Chairman Malcolm A. MacIntyre, President	7 Douglas DC-8 40 Lockheed Electra 56 Lockheed 749/1049 48 Douglas DC-7B 20 Convair 440 56 Martin 404 1 Douglas C-54 7 Douglas DC-6B (on lease)	9 Douglas DC-8 10 Boeing 720	Domestic, mostly north-south in eastern USA; Puerto Rico, Montreal, Bermuda	a) 9,567 b) 5,143,041 c) 17,026	a) 18,731 b) 17,784

** **THE FLYING TIGER LINE, INC.,** Lockheed Air Terminal, Burbank, California.

a) 16.3 b) —	R. W. Prescott, President Fred Benninger, Executive V. P. Frank B. Lynott, Executive V.P. — Operations John L. Higgins, V. P. — Sales O. R. Burghardt, Secretary & Asst. Treasurer	14 Lockheed 1049	10 Canadair CL-44	World-wide cargo services	a) 29 b) 127,647 c) 87,256	a) 16,995 b) 1,384

** **HAWAIIAN AIRLINES,** Honolulu International Airport, Honolulu, Hawaii.

a) 1.8 b) —	A. D. Lewis, President B. A. Cooke, V. P. — Finance L. D. Machado, V. P. — Operations J. C. Tobin, V. P. — Sales	1 Douglas DC-6 7 Convair 340/440 7 Douglas DC-3	1 Douglas DC-8	Domestic	a) 504 b) 88,618 c) 1,554	a) 412 b) 752

NATIONAL AIRLINES INC., P.O. Box NAL, International Airport, Miami, Florida.

a) 35.2 b) —	G. T. Baker, President & Board Chairman J. C. Brawner, Executive V. P. A. G. Hardy, Senior V. P. & Secretary J. M. Rosenthal, Senior V. P. — Industrial Relations L. W. Dymond, V. P. — Operations	3 Douglas DC-8 12 Lockheed Electra 4 Lockheed 1049 8 Douglas DC-7/7B 11 Douglas DC-6/6B 6 Convair 440	3 Lockheed Electra	Domestic in eastern USA; Miami to Cuba; to California (with Delta & American); to S. America (with Pan Am & Panagra)	a) 1,840 b) 1,168,647 c) 7,533	a) 3,486 b) 4,500

** **NEW YORK AIRWAYS, INC.,** La Guardia Airport, Flushing 71, New York, N.Y.

a) 3.4 b) —	Robert L. Cummings, Jr., President & Director William W. Hogan, V. P. & Treasurer John E. Gallagher, V. P. John H. Slate, Secretary & General Counsel Richard Wheatland, II, Asst. V. P. — Traffic & Sales	5 Vertol 44B 1 Bell 47J	10 Vertol 107	Helicopter services in New York metropolitan area	a) 125 b) 2,397 c) 21	a) 201 b) 212

NORTHWEST AIRLINES, INC., 1885 University Avenue, St. Paul, Minn.

a) 15 b) —	Croil Hunter, Chairman Donald W. Nyrop, President Gordon M. Bain, Sales V. P. Frank C. Judd, V. P. Maintenance and Station Operations Donald H. Hardesty, Treasurer	5 Douglas DC-8 15 Douglas DC-7C 23 Douglas DC-6B 12 Douglas DC-4 9 Lockheed Electra 3 Boeing Stratocruiser	—	Domestic; Tokyo, Manila, Seoul, Okinawa, Taiwan, Edmonton, Winnipeg	a) 2,139 b) 1,738,138 c) 27,954	a) 18,000 b) 7,300

PAN AMERICAN GRACE AIRWAYS, INC., 135 East 42nd Street, New York 17, N.Y.

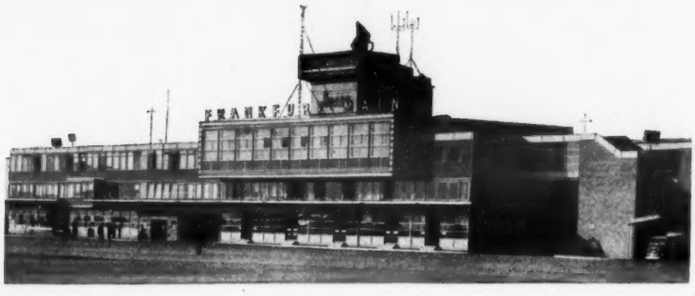
a) 16.0 b) —	Andrew B. Shea, President Douglas Campbell, V. P. & General Manager T. J. Kirkland, V. P. — Operations C. S. Collins, V. P. — Sales & Traffic L. H. Clifton, V. P. & Comptroller	3 Douglas DC-8 6 Douglas DC-7B/7F 3 Douglas DC-6B	1 Douglas DC-8	Panama to South America	a) 131 b) 187,653 c) 5,855	a) 4,671 b) 1,340

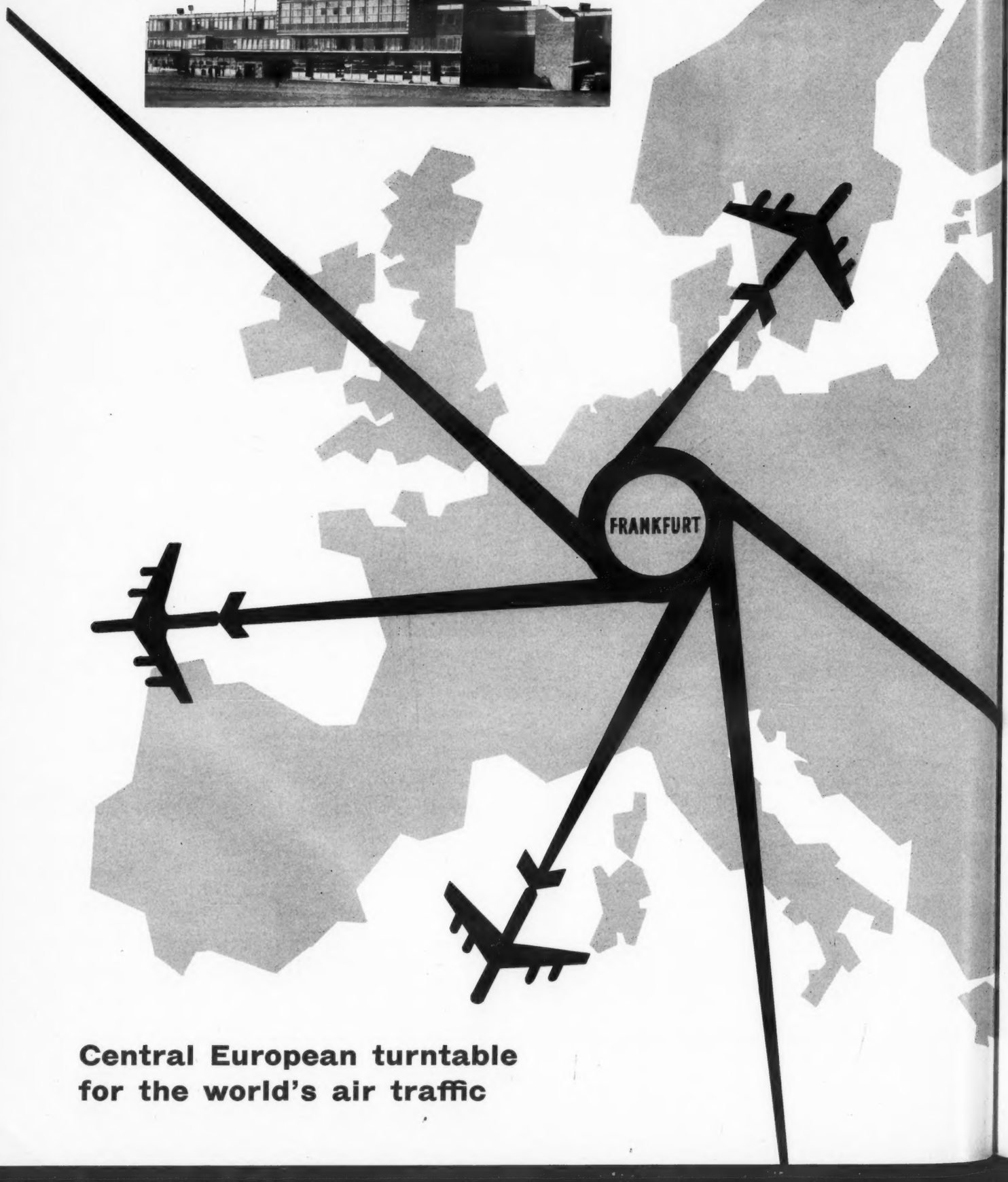
PAN AMERICAN WORLD AIRWAYS, 135 East 42nd Street, New York 17, N.Y.

a) 78.9 b) —	Juan T. Trippe, President Roger Lewis, Executive V. P. — Administration John C. Leslie, V. P. & Assistant to President Hubert A. Schneider, V. P. & General Counsel Willis G. Lipscomb, V. P. — Traffic & Sales	32 Boeing 707 32 Douglas DC-7B/C/F 45 Douglas DC-6A/B 21 Douglas DC-4 22 Boeing Stratocruiser	21 Douglas DC-8	U.S. overseas; trans-Atlantic, trans-Pacific, Latin America, Far East, Australasia	a) 3,219 b) 4,593,000 c) 115,865	a) 71,232 b) 22,497

** Associate member n.a. = not available.

Frankfurt
"Rhine-Main" Airport





Central European turntable for the world's air traffic

PILLARS OF WORLD AIR TRANSPORT

a) *Capital in U.S.$ (millions)* b) *State holding*	MANAGEMENT	AIR FLEET: Available	AIR FLEET: On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route mileage* (unduplicated) b) *Employees*
**** QUEBECAIR,** Rimouski, Quebec.						
a) n.a. b) n.a.	Romeo Crevier, President Aubert Brillant, V. P. Maurice Tessier, V.P. & Secretary Benoît Ste-Marie, General Manager	3 Fairchild F-27 6 Douglas DC-3 4 others	—	Domestic in eastern Canada	a) 191 b) 25,065 c) 352	a) 2,150 b) 255
SEABOARD & WESTERN AIRLINES INC., 80, Broad Street, New York 4, N.Y.						
a) 4.1 b) —	R. A. Norden, President A. V. Norden, V. P. W. P. Neth, V.P. A. Thomson, V.P. C. D. Brell, V.P.	9 Lockheed 1049 3 Douglas DC-4 1 Douglas DC-3 1 Curtiss C-46	5 Canadair CL-44	Cargo services to U.K., France Germany & Switzerland	a) — b) — c) 43,736	a) 6,202 b) 1,061
TRANS-CANADA AIR LINES, International Aviation Building, 1080 University Street, Montreal, Quebec.						
a) 5.0 b) 100%	G. R. McGregor, President W. Gordon Wood, V.P. — Sales H. W. Seagrim, V.P. — Operations W. S. Harvey, Comptroller	3 Douglas DC-8 49 Vickers Viscount 13 Lockheed 1049 21 Canadair North Star 9 Douglas DC-3	7 Douglas DC-8 23 Vickers Vanguard	To 8 points in Europe; 6 points in USA; 5 points in Carribbean; domestic to 40 points	a) 3,209 b) 1,828,902 c) 15,100	a) 34,503 b) 10,452
TRANS WORLD AIRLINES INC., 380, Madison Avenue, New York 17, N.Y.						
a) 119.6 b) —	Warren Lee Pierson, Chairman of the Board E. O. Cocke, Senior V.P. and System General Manager A. V. Leslie, Senior V.P. — Finance and Treasurer	25 Boeing 707 28 Lockheed 1649A 41 Lockheed 1049 69 Lockheed 049/749 1 Douglas DC-4 24 Martin 202/404	—	Transcontinental in USA and trans-Atlantic to British Isles, Europe, North Africa and Asia.	a) 5,510 b) 5,672,701 c) 62,439	a) 50,000 b) 20,000
UNITED AIR LINES INC., 5959, South Cicero Avenue, Chicago 38, Illinois.						
a) 394.6 b) —	W. A. Patterson, President Curtis Barkes, Senior V.P. — Finance & Property J. A. Herlihy, Senior V.P. — Engineering & Maintenance D. F. Magarrell, Senior V.P. — Transportation Services	26 Douglas DC-8 6 Boeing 720 45 Douglas DC-7/7A 90 Douglas DC-6/6A/6B 35 Convair 340	14 Douglas DC-8 23 Boeing 720 20 Sud-Aviation Caravelle 4 Douglas DC-7A	Transcontinental USA; Pacific coast from Mexican border to Canada; overseas to Hawaii	a) 7,521 b) 5,160,757 c) 75,209	a) 11,613 b) 21,439

LATIN AMERICA

*** AEROLÍNEAS ARGENTINAS,** Paseo Colón 185, Buenos Aires, Argentina.						
a) 15.3 b) n.a.	Dr. Ángel M. Lagomarsino, V.P. Cdre. Eugenio Revere, General Manager Héctor Rodríguez, Commercial Manager Enrique D. Bermúdez, Technical Manager	6 D.H. Comet 4 5 Douglas DC-6 6 Douglas DC-4 16 Douglas DC-3 4 Convair 240 7 others	—	Buenos Aires to 7 points in Europe; 2 points in Africa; Rio de Janeiro; domestic	a) n.a. b) n.a. c) n.a.	a) 38,588 b) 5,320
*** AEROLÍNEAS INI Y CÍA S.A.,** Av. Corrientes 1994, Buenos Aires, Argentina.						
a) 10 b) —	José Ini, General Manager Sultana Seror de Ini, V.P. Santiago Posadas, Operations Manager Jorge Rosbery, Sales Manager	Douglas DC-4	Douglas DC-6	Buenos Aires to 6 points in Latin America; Miami	a) n.a. b) n.a. c) n.a.	a) n.a. b) n.a.
*** AERONAVES DE MÉXICO S.A.,** Av. Mariano Escobedo 491, Mexico City 5, Mexico.						
a) n.a. b) n.a.	Raúl Martínez Ostos, President Tirso Carpizo, Executive V.P. Jorge Pérez y Bouras, General Manager	2 Bristol Britannia 2 Lockheed 749 4 Convair 340 2 Douglas DC-4 12 Douglas DC-3	3 Lockheed Electra	Domestic; La Paz, New York	a) n.a. b) n.a. c) n.a.	a) 7,825 b) 1,982
*** AEROVÍAS GUEST S.A.,** Paseo de la Reforma 51, Mexico City, Mexico.						
a) 1.6 b) —	Winston Guest, President George L. Monteiro, V.P.	3 Douglas DC-6 1 Douglas DC-4 3 Lockheed 1049 2 Lockheed 749	—	Mexico City to Miami, Bermuda, Azores, Panama, Lisbon; Canada	a) n.a. b) n.a. c) n.a.	a) 9,958 b) 450
AVIANCA, Aerovías Nacionales de Colombia S.A., Carrera 7, No. 16-14, Bogotá, Colombia.						
a) 2.1 b) 1.9%	Juan Pablo Ortega, President Herbert Wild, Commercial V.P. Captain Rafael Barvo, Technical V.P. Sabas Pretelt Martínez, Executive V.P. Alberto Farías, Traffic & Sales Manager	3 Lockheed 1049 4 Lockheed 749 12 Douglas DC-4 31 Douglas DC-3	2 Boeing 720B	Domestic; Latin America; USA; Europe	a) 1,211 b) 373,200 c) 55,289	a) 26,109 b) 5,886
COMPAÑÍA CUBANA DE AVIACIÓN S.A., Aeropuerto Internacional José Martí, Rancho Boyeros, Havana, Cuba.						
a) 10.7 b) 80%	Under reorganization	5 Vickers Viscount 4 Bristol Britannia 4 Lockheed 049/1049 5 Douglas DC-3	2 Boeing 707	Havana to New York, Miami, Mexico City and Madrid; domestic	a) 298 b) 139,950 c) 1,242	a) 10,150 b) 1,286
*** LÍNEA AÉREA NACIONAL,** Teatinos 384, Santiago, Chile.						
a) n.a. b) n.a.	Mauricio Yánquez Illanes, Executive V.P. Héctor Sauvageot Ibarra, Commercial Manager Jorge Jarpa Reyes, Operations Manager	7 Douglas DC-6B 16 Douglas DC-3 4 Martin 2-0-2	—	Domestic; international in South America; Miami	a) n.a. b) n.a. c) n.a.	a) 8,390 b) 1,200
*** LÍNEA AEROPOSTAL VENEZOLANA,** Bloque 1, El Silencio, Caracas, Venezuela.						
a) 21 b) n.a.	Leopoldo Correa, President Captain Carlos Hiller, Technical Manager Oscar Aguerrevere, Traffic Manager Guillermo Laya Baquero, Administrative Manager	3 Vickers Viscount 10 Lockheed 749/1049 18 Douglas DC-3 7 others	—	Domestic; South American international; USA; Europe; West Indies	a) n.a. b) n.a. c) n.a.	a) 18,856 b) 1,819
*** PANAIR DO BRASIL S.A.,** Edificio Panair, Santos Dumont Airport, Rio de Janeiro, Brazil.						
a) 61.6 b) n.a.	Manoel F. Guimarães, President and Managing Director César Pires de Melho, General Manager Captain Decio A. Vilhena, Operations Manager Haroldo P. Preston, Commercial Manager	4 Douglas DC-7C 4 Douglas DC-6C 12 Lockheed 749 5 flying boats	4 Douglas DC-8	To Europe, Africa, Near East, South America	a) n.a. b) n.a. c) n.a.	a) 32,048 b) 4,032
REAL S.A., TRANSPORTES AÉREOS, rua Conselheiro Crispiniano 379, São Paulo, Brazil.						
a) 36 b) n.a.	Capt. Linneu Gomes, President Dr. Eduardo de Mello Alvarenga, Technical Director Luiz C. Marinho de Andrade, Commercial Director Dr. Aguinaldo Junqueira Jr., Legal Director Capt. Omar Fontana, Traffic & Operations	4 Lockheed 1049 17 Convair 440 51 Douglas DC-3 13 Curtiss C-46	4 Convair 600	To Tokyo, Miami, Los Angeles; to points in Central & South America; domestic to 230 points	a) n.a. b) n.a. c) n.a.	a) 70,000 b) 7,000

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a) *Capital in U.S. $ (millions)* b) *State holding*	MANAGEMENT	AIR FLEET: Available	AIR FLEET: On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route éileage* (unduplicated) b) *Employees*
SERVIÇOS AÉREOS CRUZEIRO DO SUL S.A., 128 Avenida Rio Branco, Rio de Janeiro, Brazil.						
a) 0.85 b) —	Dr. J. Bento Ribeiro Dantas, President Dr. L. C. de Amorim Filho, Superintendent Dr. C. Emmanuel Silva, Secretary Brig. Franklin A. Rocha, Traffic João Q.V. de Carvalho, Commercial	18 Convair 240/340/440 29 Douglas DC-3 12 others	—	To Argentina, Bolivia, British & French Guiana; domestic	a) 542 b) 148,172 c) 27,488	a) 17,803 b) 4,003
VARIG S.A., Empresa de Viação Aérea Rio Grandense, Av. Borges de Medeiros 410-16º, Porto Alegre, RGS, Brazil.						
a) 0.3 b) 7%	Rubem M. Berta, President Erik de Carvalho, Director Harry Schuetz, Director Helio Smidt, Director Walter Heuer, Director	2 Boeing 707 2 Sud-Aviation Caravelle 5 Lockheed 1049 12 Convair 240 21 Douglas DC-3 14 Curtiss C-46	—	To New York & Buenos Aires; domestic	a) 584 b) 287,573 c) 14,029	a) 18,129 b) 4,375

AFRICA

AIR ALGÉRIE, Compagnie Générale de Transports Aériens, Bd. Saint-Saëns 46, Algiers, Algeria.						
a) 2.5 b) —	Jean Richard-Deshais, President Colonel Henri Alias, General Manager	3 Sud-Aviation Caravelle 2 Lockheed 749 10 Douglas DC-4 3 Douglas DC-3 3 Nord 2502	3 Sud-Aviation Caravelle	Algeria to Sahara, points in France, Switzerland, Balearic Islands	a) 488 b) 263,202 c) 5,135	a) 21,100 b) 1,203
CENTRAL AFRICAN AIRWAYS CORPORATION, Salisbury Airport, Southern Rhodesia.						
a) 2.5 b) 100%	M. Stuart-Shaw, General Manager R. P. Hartley, Asst. General Manager G. C. Draper, Commercial Manager W. B. James, Chief Accountant K. H. Greager, Engineering Manager	4 Vickers Viscount 6 Douglas DC-3 6 D.H. Beaver	—	To Rome and London; South Africa, Kenya, Tanganyika, Portuguese East Africa	a) 154 b) 79,280 c) 270	a) 12,760 b) 1,156
D.E.T.A., DIRECÇÃO DE EXPLORAÇÃO DOS TRANSPORTES AÉREOS, Av. do General Machado, 2-2º, Lourenço Marques, Mozambique.						
a) 1.2 b) 100%	H. A. Brasão de Freitas, Director General Lt.-Colonel Armando Rui Cerqueira da Silva Paes, Manager Abel Neves de Azevedo, Deputy Manager	5 Douglas DC-3 8 others	—	Lourenço Marques to South and Central Africa; domestic	a) 35 b) 16,591 c) 1,706	a) 5,373 b) 461
D.T.A., DIVISÃO DE EXPLORAÇÃO DOS TRANSPORTES AÉREOS, Rua Pereira Forjaz, Carvalho & Freitas Building, P.O. Box 79, Luanda, Angola.						
a) n.a. b) 100%	Lt.-Colonel J.S. Medina, Director E. M. Leitão, Maintenance Supt. Captain E. Ferreira d'Almeida, Operations Supt. M. Carmona, Commercial Manager	7 Douglas DC-3 4 Beechcraft D-18	—	Portuguese West Africa domestic; former French Equatorial Africa; Congo	a) 39 b) 10,827 c) 168	a) 5,300 b) 307
EAST AFRICAN AIRWAYS CORPORATION, Airways Terminal, Nairobi, Kenya.						
a) 0.62 b) 100%	M.C.P. Mostert, General Manager A. V. Gill, Asst. General Manager	2 D.H. Comet 4 3 Canadair DC-4M 9 Douglas DC-3 4 D.H. Dominie	—	Rome, London, Karachi, Bombay; domestic and intra-African services	a) 130 b) 84,261 c) 1,706	a) 22,361 b) 1,541
ETHIOPIAN AIRLINES, INC., P.O. Box 1755, Addis Ababa, Ethiopia.						
a) 1.4 b) 100%	H. E. Dedjazmatch Mangashia Seyoum, President & Chairman of Board Ato Yawand Wossen Mangasha, V.P. Victor H. Harrell, Jr., General Manager	3 Douglas DC-6B 7 Douglas DC-3 2 Convair 240 5 helicopters	2 Boeing 720B	To Khartoum, Cairo, Athens, Frankfurt; international to neighbouring countries; domestic	a) 96 b) 55,680 c) 2,199	a) 9,782 b) 812
SOUTH AFRICAN AIRWAYS, Railway Headquarters, Johannesburg, South Africa.						
a) n.a. b) 100%	D.H.C. du Plessis, General Manager J. P. Hugo, Deputy General Manager J. G. Grové, Chief Executive, Airways Colonel J.D.T. Louw, Chief Airways Manager	2 Boeing 707 7 Vickers Viscount 4 Douglas DC-7B 5 Douglas DC-4 6 Douglas DC-3 4 Lockheed 749	1 Boeing 707	Domestic; points in Africa; 6 points in Europe; Australia	a) 319 b) 255,822 c) 3,650	a) 45,729 b) 2,702
* ** **SOUTH WEST AIR TRANSPORT (PTY.), LTD.**, P.O. Box 173, Windhoek, South West Africa.						
a) 0.056 b) n.a.	P.H.M. du Plessis, Chairman G. T. Van Rooyen, Managing Director	7 Ryan Navion 2 Piper Apache 6 Cessna 175/182	—	Domestic in S.W. Africa	a) n.a. b) n.a. c) n.a.	a) 550 b) n.a.
WEST AFRICAN AIRWAYS CORPORATION (NIGERIA) LTD., P.O. Box 136, Lagos, Nigeria.						
a) 16.6 b) 51%	Chief T. T. Solaru, Chairman L.E.T. Evans, Executive Director	7 Douglas DC-3	—	Domestic and international in West and Central Africa; Europe (with BOAC)	a) 58 b) 241 c) —	a) 5,718 b) 1,384

NEAR AND FAR EAST

* **AIR CEYLON**, Hemas Building, York Street, Colombo 1, Ceylon.						
a) 0.63 b) n.a.	J.L.M. Fernando, Managing Director F.G.A. Van Moll, Deputy Managing Director Kenneth de Croos, Manager, Traffic	1 Lockheed 1049 2 Douglas DC-3	—	Domestic; to India and Pakistan, Near East, Rome, London, Amsterdam, Singapore	a) n.a. b) n.a. c) n.a.	a) 8,977 b) 300
AIR INDIA INTERNATIONAL, New India Assurance Building, Mahatma Gandhi Rd., Bombay 1, India.						
a) 34.8 b) 100%	J.R.D. Tata, Chairman B. R. Patel, Vice Chairman and General Manager A. C. Gazdar, Technical Director S. K. Kooka, Commercial Director N. J. Pavri, Financial Controller	3 Boeing 707 9 Lockheed 1049 1 Douglas DC-3 (freighter)	1 Boeing 707	India to U.K., USA, Japan, Australia, Indonesia, East Africa, USSR, Czechoslovakia	a) 92 b) 266,442 c) 8,686	a) 27,692 b) 4,612
AIR LIBAN, Place Riad Solh, Beirut, Lebanon.						
a) 1.0 b) —	Henry Naccache, President J. Peyrondet, Commercial Director Michel Tabet, Secretary General	3 Douglas DC-6C 1 Douglas DC-4 3 Douglas DC-3	1 Sud-Aviation Caravelle	Points in Middle East, Africa & Europe	a) 71 b) 48,279 c) 1,210	a) 25,000 b) 483
AIR VIETNAM, Nguyen-Hue, 116, B.P.217, Saigon, Vietnam.						
a) 0.514 b) 75%	Nguyen-Van-Khai, President Nguyen-Tan-Trung, Assistant to President	1 Douglas DC-4 6 Douglas DC-3	—	Saigon to Hong Kong & points in South East Asia; domestic	a) 73 b) 26,060 c) 414	a) 12,000 b) 580
CIVIL AIR TRANSPORT, 46, Chung Shan Road, North Second Section, Taipei, Taiwan.						
a) 25.7 b) —	Wang Wen-San, Chairman of the Board Hugh L. Grundy, Managing Director Clyde S. Carter, Secretary Amos Hiatt, Treasurer Var M. Green, V.P. — Traffic & Sales	1 Douglas DC-6B 2 Douglas DC-4 5 Douglas DC-3 18 Curtiss C-46 2 PBY-5A	1 Convair 880	Domestic; to 6 points in Far East	a) 119 b) 40,890 c) 1,034	a) 5,983 b) 613

* No information available direct from company; accuracy not guaranteed ** Associate member n.a. = not available.

PILLARS OF WORLD AIR TRANSPORT

a) *Capital in U.S.$ (millions)* b) *State holding*	MANAGEMENT	AIR FLEET — Available	AIR FLEET — On Order	PRINCIPAL ROUTES	1959 a) *Passengers* b) *Passenger-miles* c) *Freight t/mi* (in 1,000s)	a) *Route mileage* (un-duplicated) b) *Employees*
EL AL ISRAEL AIRLINES LTD., 76, Maza Street, P.O. Box 438, Tel Aviv, Israel.						
a) 2.7 b) 74.5%	Brig. Gen. E. Ben-Arzi, Managing Director H. Sanderson, Deputy Managing Director, Finance & Administration M. Ben-Ari, Deputy Managing Director, Commerce L. Pedretti, Economic Adviser	4 Bristol Britannia 4 Lockheed 049	2 Boeing 707	Israel to Middle East, Europe, USA, South Africa	a) 99 b) 229,202 c) 4,739	a) 25,164 b) 1,511
* **GARUDA INDONESIAN AIRWAYS N.V.**, Djalan Nusantara 15, Djakarta, Indonesia.						
a) 0.1 b) n.a.	Dr. M. Soetoto, President Dr. R. Sugoto, Executive V.P. Dr. C. A. Mochtar, Executive V.P.	19 Convair 240/340/440 20 Douglas DC-3	3 Lockheed Electra	Domestic; to Manila, Singapore, Bangkok and North Borneo	a) n.a. b) n.a. c) n.a.	a) 16,570 b) 3,966
INDIAN AIRLINES CORPORATION, Thapar House, Janpath, New Delhi, India.						
a) 31.3 b) 100%	A/V/M P. C. Lal, General Manager J. S. Parakh, Financial Comptroller T. D. Kumar, Engineering Manager Biren Mukerji, Chief Traffic Manager Capt. J. M. Engineer, Chief Operations & Training Manager	10 Vickers Viscount 5 Douglas DC-4 58 Douglas DC-3 12 Vickers Viking 7 D.H. Heron	5 Fokker F.27	To points in Afghanistan, Pakistan, Nepal, Burma & Ceylon; domestic	a) 645 b) 318,691 c) 13,856	a) 23,064 b) 9,551
IRANAIR, Iranian Airways, Avenue Saadi, Teheran, Iran.						
a) 0.36 b) —	Reza Afshar, President & Managing Director Houshang Afshar, Assistant Managing Director Capt. John Waterman, Director of Operations Richard Bennett, Director of Sales	3 Vickers Viscount 2 Douglas DC-4 13 Douglas DC-3	—	ToKarachi, Baghdad, Damascus, Beirut, Frankfurt, Kuwait & 14 domestic points.	a) 99 b) 24,673 c) 2,006	a) 13,999 b) 678
IRAQI AIRWAYS, New Railway Station Building, Baghdad West, Iraq.						
a) n.a. b) 100%	Muhammed Raouf Hassan, Manager Fakhri Hussain, Deputy Manager Yousif Al-Khury, Flight Captain Abbass Ali Salman, Chief Engineer	4 Vickers Viscount 1 D.H. Dove	—	Points in Near & Middle East, Europe & India	a) 68 b) 26,036 c) 468	a) 10,915 b) 488
JAPAN AIR LINES, Tokyo Building, 2-chome, Marunouchi, Chiyodaku, Tokyo, Japan.						
a) 26.5 b) 63%	Seijiro Yanagita, President Shizuma Matsuo, Executive Vice-President	2 Douglas DC-8 4 Douglas DC-7C 5 Douglas DC-6B 10 Douglas DC-4 1 Beechcraft	3 Douglas DC-8 3 Convair 880	To U.S. West Coast, Hong Kong, Singapore, Bangkok, Taipei, Okinawa; domestic	a) 567 b) 464,292 c) 7,261	a) 28,816 b) 2,530
MALAYAN AIRWAYS LTD., Airways House, Raffles Place, Singapore 1.						
a) 2.6 b) —	Capt. R. P. Mollard, General Manager A. A. Cooper, Secretary/Chief Accountant Capt. J. R. Brown, Operations Manager A. G. Beohm, Traffic Manager S. H. Edwards, Engineering Supt.	2 Vickers Viscount 1 Lockheed 1049 9 Douglas DC-3	—	Points in Malaya, Thailand, Indonesia, Sarawak & N. Borneo	a) 155 b) 44,588 c) 1,274	a) 7,991 b) 1,329
MIDDLE EAST AIRLINES COMPANY S.A., Maktabi Building, Abdul Aziz Street, Beirut, Lebanon.						
a) 2.0 b) —	Sheikh Najib Alamuddin, Chairman & Managing Director Asad Y. Nasr, Executive Assistant Managing Director	7 Vickers Viscount 4 Douglas DC-3	4 D.H. Comet 4C	Middle East, India, Pakistan, & 7 points in Europe	a) 148 b) 91,592 c) 1,463	a) 19,689 b) 1,015
MISRAIR, Almaza Airport, Heliopolis, Egypt.						
a) 3.9 b) 51%	Hassan Mahmoud, Managing Director M.S. El-Miligui, General Manager M. F. Raafet, Dep. Gen. Man. Commercial H. Tewfik, Dep. Gen. Man. Technical A. Mokbel, Dep. Gen. Man. Administrative	3 D.H. Comet 4C 7 Vickers Viscount 5 Douglas DC-3 3 Vickers Viking 1 Beechcraft	—	To points in Europe, Africa & Middle East	a) 195 b) 87,578 c) 1,061	a) 11,510 b) 1,029
PAKISTAN INTERNATIONAL AIRLINES CORPORATION, Karachi Airport, Karachi, Pakistan.						
a) 19.0 b) 100%	A/C M. Nur Khan, Managing Director Enver Jamall, Operations Director A. Z. Rehman, Comptroller	1 Boeing 707 5 Lockheed 1049 3 Vickers Viscount 10 Douglas DC-3	5 Fokker F.27	Karachi to Europe, Middle East, India, Burma & Afghanistan; domestic	a) 200 b) 95,168 c) 7,551	a) 16,757 b) 4,194
PHILIPPINE AIR LINES, M.R.S. Building, Plaza Cervantes, Manila, Philippines.						
a) 3.0 b) 54.2%	Col. Andres Soriano, President Andres Soriano, Jr., First Vice President Rafael Igoa, Executive Vice President	3 Vickers Viscount 2 Fokker F.27 25 Douglas DC-3 6 others	2 Douglas DC-8	To Hong Kong; domestic to 68 points	a) 643 b) 147,323 c) 2,889	a) 12,500 b) 2,312
SUDAN AIRWAYS, P.O.B. 253, Khartoum, Sudan.						
a) n.a. b) 100%	Abdel Bagi Mohamed, General Manager Yousif Bakheit Arabi, Traffic Manager D. W. Graham, Chief Pilot R. D. Collins, Chief Engineer	1 Vickers Viscount 7 Douglas DC-3 4 D.H. Dove	1 Vickers Viscount	Domestic; to Middle East; to Athens-Rome-London	a) 40 b) 23,912 c) 772	a) 8,940 b) 469

AUSTRALASIA

** **ANSETT-A.N.A.**, 289 William Street, Melbourne C.1., Victoria, Australia.						
a) 22 b) —	R. M. Ansett, Chairman and Managing Director F. Pascoe, General Manager P. J. Gibbes, Operations Manager J. A. North, Commercial Manager I. G. Webster, General Sales Manager — International	3 Lockheed Electra 3 Fokker F.27 9 Vickers Viscount 2 Douglas DC-6B 2 Douglas DC-4 1 Douglas DC-3 2 Convair 440 1 Bristol 170 4 helicopters	—	Connections between State capitals	a) 943 b) 434,505 c) 16,271	a) 19,087 b) 3,792
** **NEW ZEALAND NATIONAL AIRWAYS CORPORATION**, Aotea Quay, P.O. Box 96, Wellington, New Zealand.						
a) 6.4 b) n.a.	Captain J. J. Busch, General Manager D. E. Foley, Deputy General Manager D. A. Patterson, Assistant General Manager	3 Vickers Viscount 26 Douglas DC-3 2 D.H. Dominie	1 Vickers Viscount 8 Fokker F. 27	Domestic	a) 558 b) 197,110 c) 3,196	a) 3,459 b) 1,738
QANTAS EMPIRE AIRWAYS LIMITED, Qantas House, 70, Hunter Street, Sydney, N.S.W., Australia.						
a) 31 b) 100%	C. O. Turner, Chief Executive & General Manager Captain G. U. Allan, Deputy Chief Executive & Deputy General Manager C. W. Nielson, Director of Commercial Services Captain R. J. Ritchie, Director of Technical Services F. C. Derham, Secretary & Director of Finance	7 Boeing 707 4 Lockheed Electra 8 Lockheed 1049 3 Douglas DC-4 8 Douglas DC-3 4 D.H. Otter	3 Boeing 707	Services to Europe and U.K. via India and North America; New Zealand; Hong Kong; Japan; points in South Pacific; South Africa	a) 201 b) 564,461 c) 18,889	a) 73,463 b) 6,737
TASMAN EMPIRE AIRWAYS LIMITED, Airways House, Customs Street East, Auckland, New Zealand.						
a) 5.6 b) 100%	F. A. Reeves, General Manager J. W. Veale, Assistant General Manager G. B. Bolt, Chief Engineer H. M. Denton, Commercial Manager A. A. Watson, Secretary	3 Lockheed Electra 3 Douglas DC-6 1 Solent Mk.IV	—	Between Australia and New Zealand; to Pacific island points	a) 72 b) 97,621 c) 654	a) 12,802 b) 692
** **TRANS-AUSTRALIA AIRLINES**, 339 Swanston Street, Melbourne C.1., Australia.						
a) 13 b) 100%	John Ryland, General Manager Captain J. Chapman, Assistant General Manager J. L. Watkins, Director of Engineering R. E. Pope, Director of Finance Captain R. E. Bailey, Director of Operations	3 Lockheed Electra 9 Fokker F.27 15 Vickers Viscount 3 Douglas DC-4 14 Douglas DC-3 2 helicopters	—	Australian domestic	a) 871 b) 426,000 c) 9,700	a) 29,457 b) 4,062

* No information available direct from company; accuracy not guaranteed ** Associate member n.a. = not available.

Production Planning and Control in the Airlines

By R. Boyd Ferris,

Assistant to Technical Director, International Air Transport Association, Montreal

Production Planning and Control is probably one of the least-known activities in the airline business today. Paradoxically, it is one of the most powerful tools available to management for cutting costs in the jet age.

In these days of large, expensive aircraft, equally costly spares and rising labour bills, an airline must keep its aircraft serviceable and in the air if it is to survive. Management is faced with the challenge of making the best possible use of its aircraft. It must develop effective operating plans to meet this challenge but it must also ensure that safe, serviceable aircraft are available to fulfil the operating plan. And it is in the production of serviceable aircraft—the maintenance and overhaul job—that Production Planning and Control, or PPC, enters the picture.

An aircraft is one of the most complex machines ever designed for transportation. Nowhere, perhaps, does this show more strikingly than in the amount of planning required to keep it serviceable. Airframes must be inspected; engines and airborne equipment must be removed, overhauled and replaced; spare parts must be provided and materials available in the right place at the right time. And all of this must be done according to a predetermined plan which avoids imposing violent fluctuations in workload on the facilities and manpower of the maintenance and overhaul organization. It is up to PPC to see that this is accomplished and that it is accomplished effectively and economically.

The importance of having good PPC is evident when one considers that the airlines' maintenance and overhaul bill normally constitutes about 30% of the airline's *total* annual costs. Moreover, small savings in maintenance and overhaul have always had a way of mushrooming into the big savings which can make the difference between profit and loss.

But however important it may be, PPC has sometimes suffered in the past from ignorance of its aims, its purpose, or even its very existence. To begin with a definition, therefore, PPC may be described as the planning which precedes the actual maintenance and overhaul work *plus* the follow-up action required both during and after execution of the work. Its activities can be divided into eight main categories: production forecasting, establishment of methods and standards, planning of manpower, planning of materials, planning of production facilities, scheduling and control of work, analysis of production performance, and analysis of budget and costs. Since an understanding of these functions is fundamental to a grasp of the role of PPC, a fuller explanation seems warranted.

Production forecasting is the process of estimating the workload on the maintenance and overhaul department which results from management's requirements for serviceable aircraft. Based on the operating plan for flying hours and flight schedules, it must also take account of technical limitations of the equipment and of proposed modification programmes and other projects. Moreover, the forecast should contain a cushion for unforeseen work arising out of incidents or accidents in day-to-day flying. Good forecasting is the foundation of good planning, for unless the foundation is solid, the superstructure will be shaky.

Methods and standards are also fundamental to good planning and control. In theory, it is desirable to have production methods established for each particular job and to specify standards for the material, manpower, equipment, and facilities needed for the work. In practice, however, the degree to which methods and standards can be introduced will vary. Much remains to be done towards developing realistic material standards for planning purposes.

Manpower planning involves the efficient allocation of manpower in order to meet the forecast requirements and the established work standards. Seasonal fluctuations in the operating plan, union practices, and the changing pattern of skills required are typical of the factors which will affect planning in this phase.

Material planning ensures that adequate spare parts and materials will be available with the minimum of delay whenever and wherever they are required throughout the airline's network. Such questions as pooling of spares, inventory policies, development of component lives, and the service available from manufacturers, all loom large in material planning. Careful control must be exercised constantly in this phase to avoid unnecessary stocking of items and excessive expenditure.

Planning of production facilities is required in order that the necessary tools, shop space and related facilities will all be available when it comes to translating the manpower and material planning into action.

Scheduling and control of the work follows naturally from the foregoing planning phases. It involves detailed loading of the work on the shops and hangars in accordance with the time and money available and it demands careful follow-up action to determine how the work is progressing. This is a complex process which calls for flexibility in the system and a good feed-back of information.

Analysis of production performance takes place when the work has been completed. It is valuable in detecting adverse trends and permits rectification action to be taken before they become serious. If properly devised, the performance analysis can serve as a yardstick of maintenance and overhaul efficiency and it can also help in inter-airline comparisons.

Analysis of budget and costs is another facet of the follow-up control action—and a very important one. Costs must be constantly checked against budget allocations to see that the maintenance and overhaul department is 'living within its means' and that future budgeting will be realistic.

From this brief explanation, the general outline of *what* PPC does in an airline can be sketched in. But *how* PPC sets about doing its job is not so easy to pin down.

As might be expected, the approach to PPC will vary greatly from airline to airline. Many factors contribute to these variations: the type and number of aircraft operated, the airline's route structure, its geographical location and management policies, are but a few. But this very diversity in approach has also been the source of unsuspected dividends.

For several years now there has been growing awareness in the airlines of the important part which PPC can play in their drive for greater efficiency. With this awareness has come the recognition that much could be gained by tackling the problem on an industry-wide basis. As a result, a Production Planning and Control Group was set up by IATA over two years ago and a similar group was also formed by the Air Transport Association for the North American carriers.

In gathering together PPC specialists from five continents—representing the large airlines as well as the small ones—IATA soon found it had tapped some of the best knowledge and experience available in this relatively new field. And as often happens in such a new and complex field, ingenious solutions had already emerged for a number of specific problems.

One airline had developed a particularly progressive system of budgeting, with independent administrators attached to the various levels of engineering and maintenance management to act in an advisory capacity on budgeting and cost control matters, and with a method of inter-departmental charging for work done within the company.

Another airline had introduced a comprehensive labour incentive scheme which provided bonuses to workers on most maintenance and overhaul work. In the process it had found that, as a by-product, a wealth of information was thereby made available for planning purposes.

Other companies were experimenting with provisioning formulae, one of which had resulted in a novel slide-rule for use in ordering spare parts.

Still others were working out a "continuous" maintenance concept whereby all of the regular maintenance and overhaul for their new aircraft would be carried out during the layover periods between scheduled flights, thus reducing the total number of aircraft required by the airline.

The exercise was a stimulating one. Some of the problems differed, many of the problems were common, but the Group found that they could benefit from the experience, the setbacks and the successes of others.

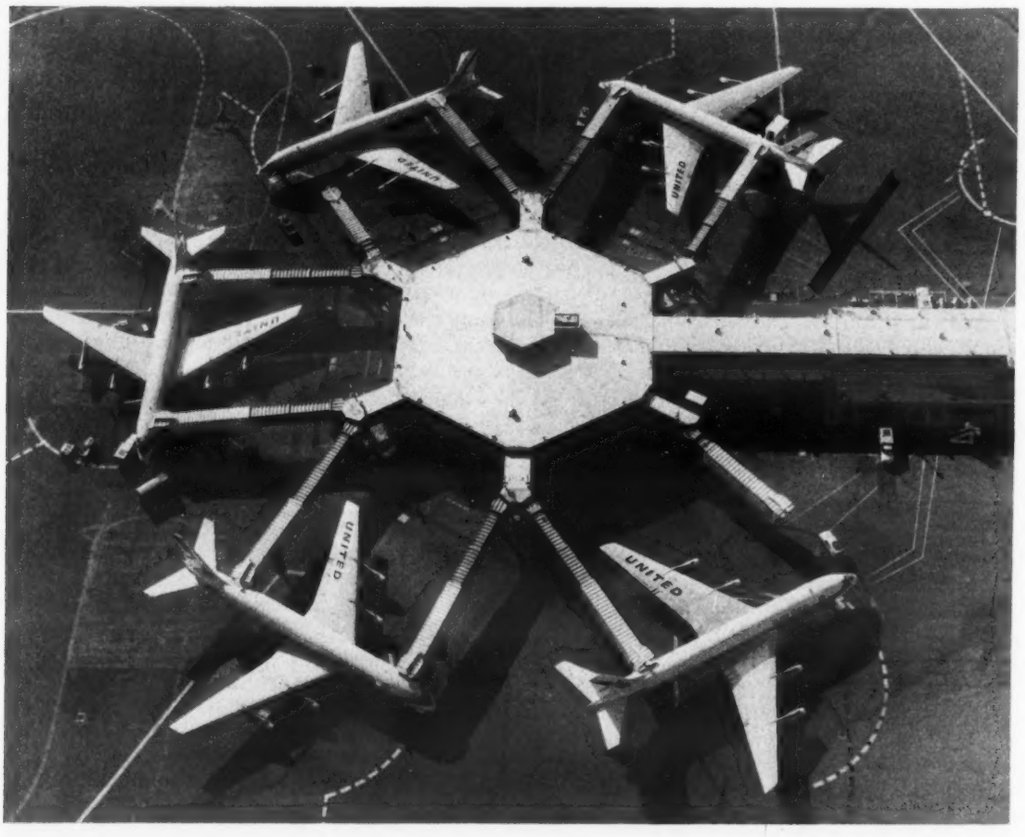
Gradually the IATA Group began to take on some of the colouring of a consultative body on PPC matters to the airline industry. In the early stages, attention was focussed primarily on finding out how PPC was organized in the different airlines and how it functioned. From this exchange of information broad similarities soon began to emerge, giving rise to the hope that general guidance could be developed on the subject. This hope has materialized in the form of an IATA PPC Handbook which aims at presenting a consolidated view of what constitutes good planning concepts and techniques in PPC. Several chapters of the Handbook have already been produced and further work is progressing rapidly.

In starting work on this Handbook, top priority went to the problem of language. PPC, like many another new activity, got its start by borrowing heavily from other fields—both in techniques and in terminology—with resulting confusion to outsiders and even to the experts themselves on occasion. Initially, therefore, there had to be some agreement on the terms to be used in talking about PPC. From this beginning, other chapters dealing with the scope and the responsibilities of PPC in an airline are taking form.

The IATA Handbook does not aim at standardization, but rather at a distillation of the current experience and thinking of men who are active in this field. It provides the planner with a framework to use in standing back and taking measure of the job he is doing for his own airline. It also gives him a book which he can hand to anyone who asks "What is Production Planning and Control?"—leaving him free to get on with his work.

This last observation is not quite so flippant as might appear on the surface, for the planner is faced with some very fundamental issues today. Cost of spare parts for the jets is much greater than it was for piston-engined aircraft, but they have been outdistanced in turn by the penalties incurred by a missing part. As labour prices rise the cost of fluctuations in workload also goes up, yet it might now be worth scheduling such fluctuations deliberately if it meant higher aircraft utilization. Glowing promises are made by operations research and electronic data processing for those who master their intricacies—and avoid their pitfalls.

There can be no single right answer to these and other questions being posed daily to planners. Yet the planner must come up with the answer which is right for his own airline. He can look for signposts from what other airlines are doing, he can look to himself for ingenuity, but he needs the understanding of his management if he is to meet with success.



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United Air Lines' terminal facility at San Francisco International Airport enables five big jets—here Douglas DC-8s—to be handled at once. The covered, soundproof "Jetways" can be swivelled and telescoped. Although an installation of this kind is expensive to purchase, it soon pays its way in peak traffic periods, as apron operations and passenger movements are kept completely separate and can therefore proceed simultaneously and without hampering each other. As the aircraft are laid out in a star-shaped pattern, their engine exhaust does not reach the adjacent aircraft stands; they can therefore manœuvre under their own power without interfering with the handling operations going on nearby. Not only do the covered "Jetways" shield passengers from noise and bad weather; they also spare them the effort of having to climb stairs . . . the ultimate in comfort in the jet age.

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Bloodhound is guided by a sophisticated homing system in which a ground-based radar illuminates and tracks the target. Missiles can be fired singly or in salvoes. The ability to fire salvoes provides the Air Defence Controller with the operational flexibility he requires.

Bloodhound is aerodynamically unique. It employs a monoplane moving wing configuration which both lifts and steers the missile and gives quick response, especially at high altitudes.

Bloodhound was designed with development potential which is now being exploited by the RAF to meet more advanced threats. The range at all altitudes is increased as also is the ability to deal with faster targets and enemy electronic counter measures.

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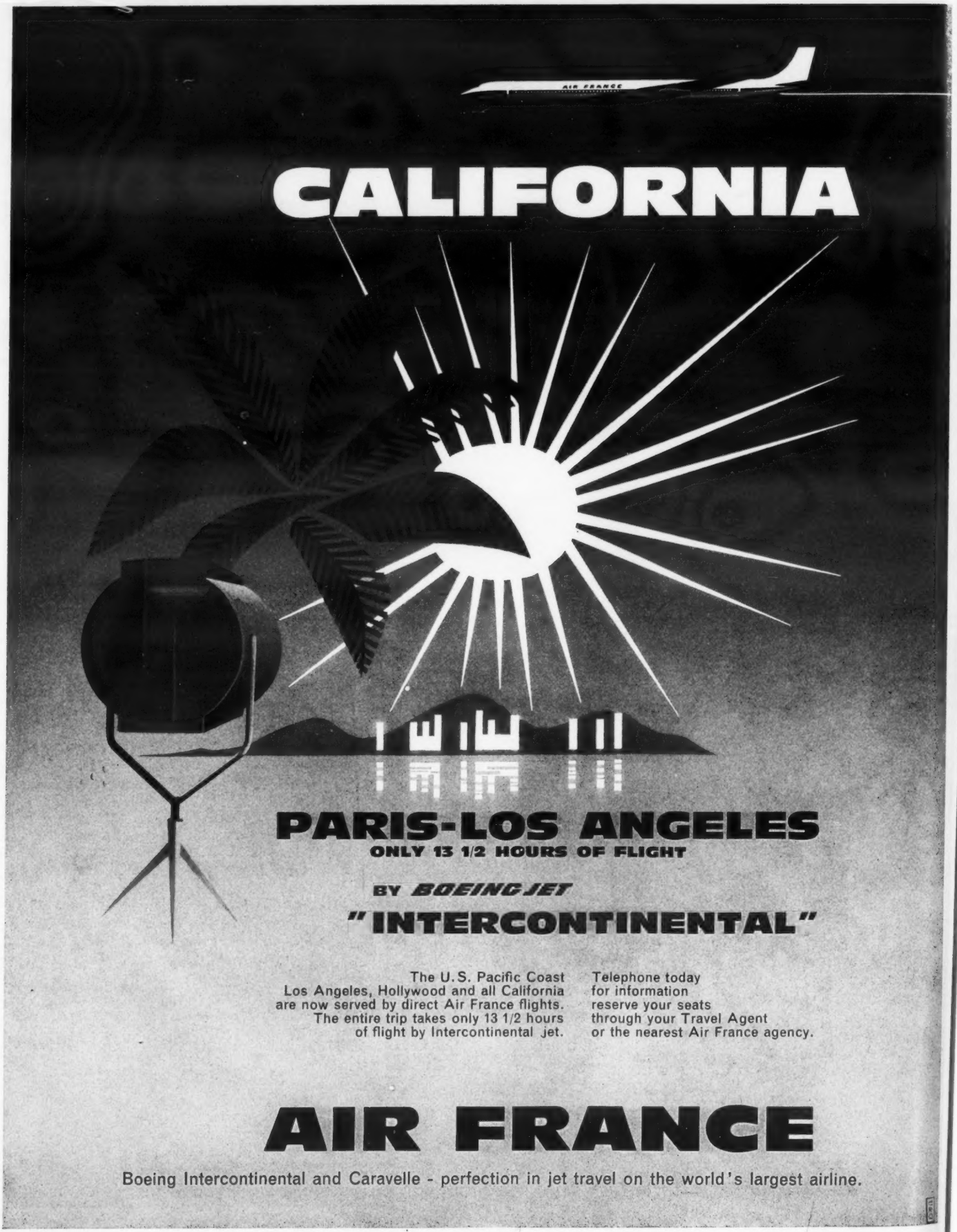
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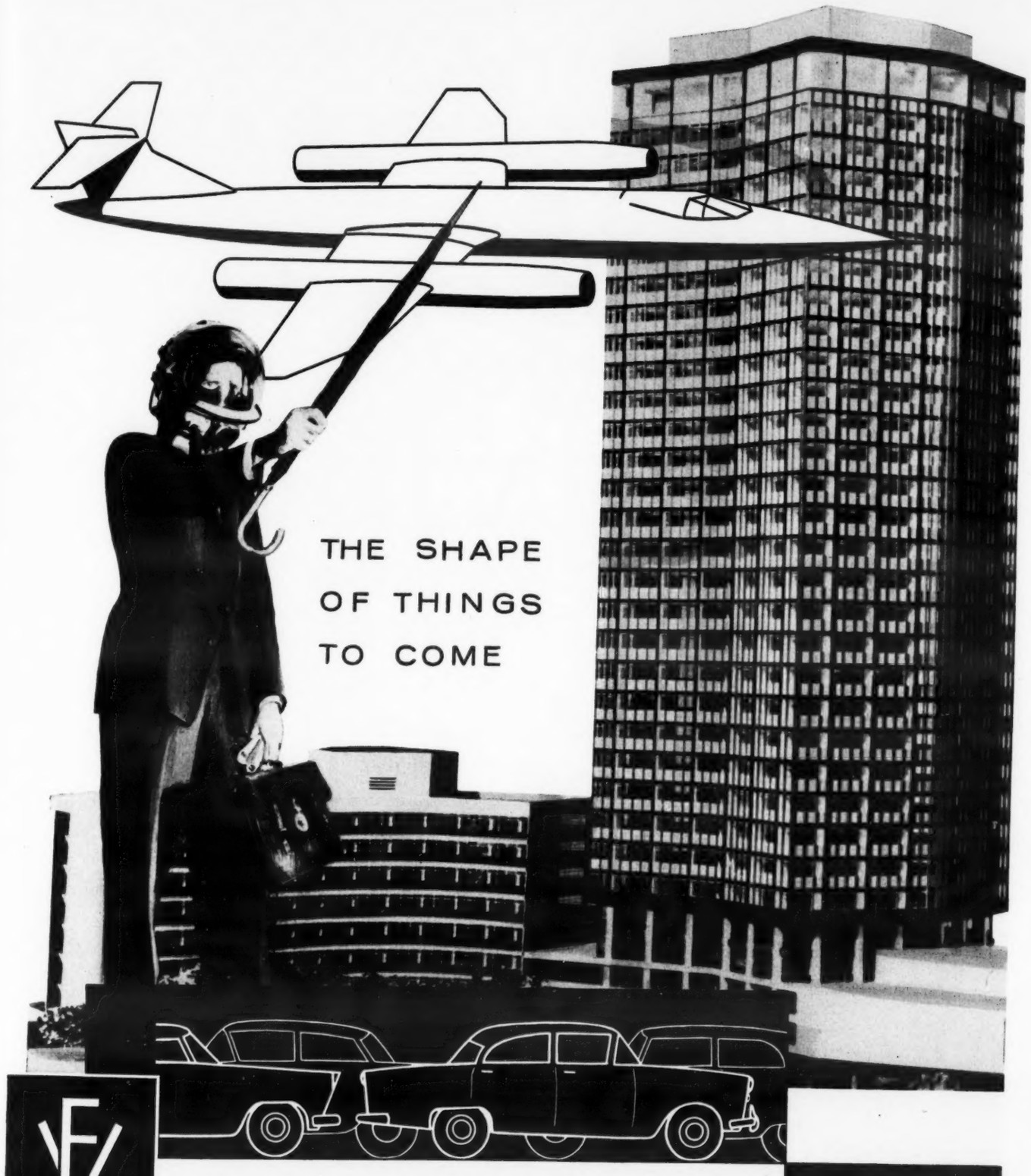

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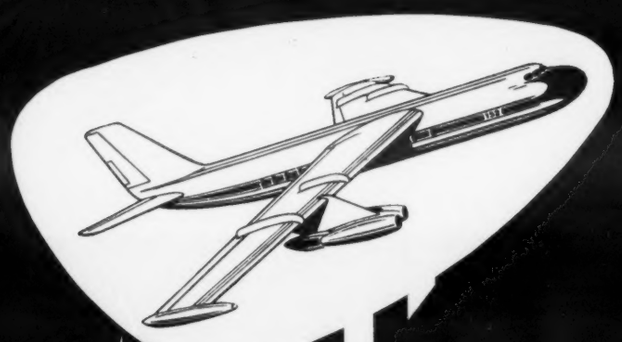

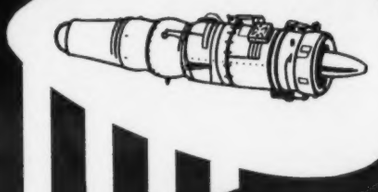

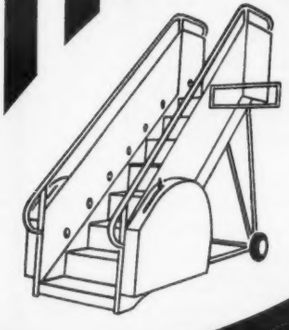

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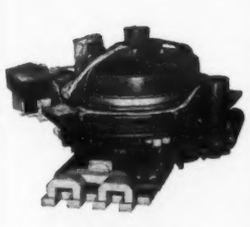

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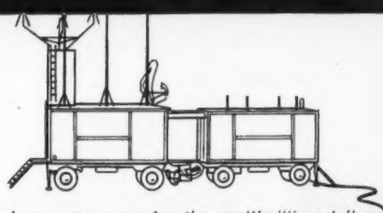

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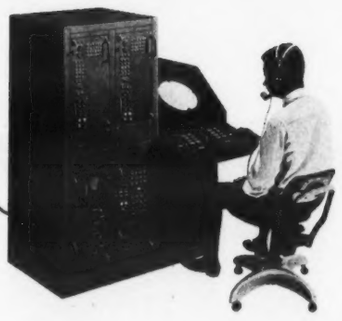

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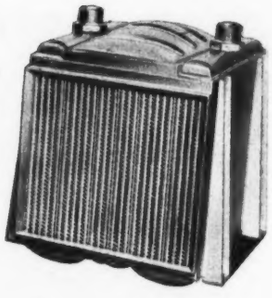

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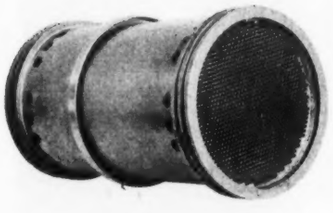

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Single-Seat Combat Aircraft

5. The Saab Draken Weapons System*

To evaluate the achievements of the small country of Sweden in the aircraft industry, one must first compare its population of a mere 7.5 million with that of its big "rivals": Soviet Union 208 million, USA 177 million, Britain 52 million and France 45 million. In the face of rising costs and technical complications, more than one Great Power has been forced to engage in joint enterprises with others, but the Swedish industry must rely more or less entirely on itself. Against this background Sweden's success in developing, within a decade, a weapons system in the shape of the Saab *Draken* which need not shrink from comparison with those of other, economically much stronger countries is indeed impressive.

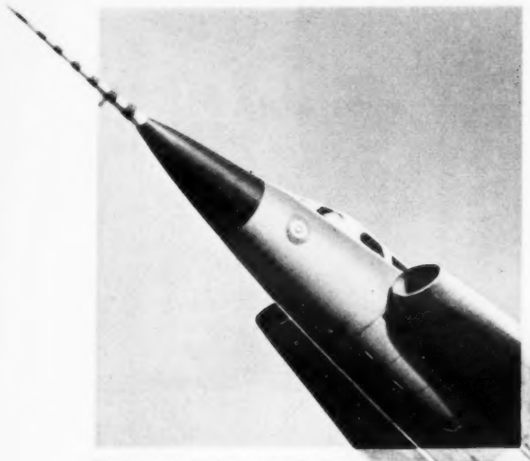
Behind this imposing industrial rise stands the iron imperative of self-defence. Only a few hundred miles separate Sweden from the Soviet Union and other members of the Warsaw Pact; in the West it borders directly on Norway and Denmark, both of them members of NATO since 1949. In an armed conflict Sweden would be a strategically valuable deployment area for both sides. In the view of the Swedish Army Command, the policy of neutrality can be combined with national security only if the country has a defensive force strong enough to make any attack appear a risky business, if not a hopeless undertaking. The Swedish General Staff is concerned above all about the danger of attacks from the air and attempted invasions from the sea. Sweden's sea coast measures 1,600 nautical miles in length and forms more than half her national frontiers. Considering the very brief warning that would be received of impending air attack, only an extremely mobile defence system can offer any chance of success, with the modest expenditure possible. It therefore comes as no surprise to learn that the main weight of Sweden's defence effort has for many years been placed on a systematic strengthening of her air defences. At the present day roughly 40 percent of the military budget is spent on the Air Force.

Far-sighted planning

Development of the *Draken* weapons system goes back to 1949, when the Swedish Air Force began to look around for a successor to the "Flying Barrel" (Saab J29)—at a time when the first prototype of the J29 had barely got into the air. The Saab factory was commissioned to study the technical and military requirements for such a development. Originally the Air Force demanded an interceptor with transonic speed, but in the course of prolonged discussions between industry, General Staff and aviation authorities a programme for an all-weather multi-purpose combat aircraft finally took shape. The aircraft was to be armed with cannon, air-to-air rockets and guided missiles, and further equipped with search, fire control and missile guidance radar. It was to be suitable not only for air defence, but also for attacks on ground targets. Other requirements were long range, to enable whole squadrons to be transferred non-stop from one end of the country to the other in case of need; short take-off and landing distances; simplicity of maintenance and

This Saab 210, with main dimensions roughly half those of the *Draken*, was used to gain practical experience of the aerodynamics of the double delta wing. Standing, centre, in front of the aircraft, is Bengt Olow, Saab's Chief Test Pilot.

* Continuing the series of articles on multi-purpose single-seat combat aircraft in Nos. 3, 4 and 7, 1960.



During tests in Switzerland's Central Alps, this *Draken* proved that it can operate from small, mountain-ringed airfields and manoeuvre along narrow valleys. For these achievements it was awarded the Swiss Alpine Badge (painted on the fuselage nose underneath the wind screen).

speedy operational readiness. In addition, the design had not only to meet contemporary operational requirements, but also to be adaptable to future needs. There is no need to stress that the cost of the development and operation had to be kept within reasonable bounds. When drawing board work began on the *Draken*, there were no operational supersonic aircraft, and the only supersonic research aircraft was America's Bell X-1. Once the basic features had been agreed upon, the relevant departments began on the actual project work. Regular discussions were held with all concerned in designing, building and operating the aircraft, to ensure that all would work single-mindedly towards the common goal and that there would be no duplication of effort. This procedure had already proved highly satisfactory in the development of earlier Saab jets and enabled impressive results to be achieved with a minimum of expense.

Svenska Aeroplan Aktiebolaget employs some 6,000 persons, a labour force which is also quite modest compared with those of similar industries in other countries. By calling on the efforts of all other national organizations concerned with aviation, however, the company is able to accomplish feats which would otherwise require a vastly greater staff.

These, then, are the conditions under which the Saab *Draken* weapons system came into being.

Development work

Saab first produced a design for an aircraft with a pure delta wing. With this wing form, however, the centre of pressure lies well in front of the wing centre of gravity, and a long nose is required to balance out this moment. This not only augments weight, but also appreciably increases drag at supersonic speeds. The requirement for the biggest possible airframe volume combined with small frontal area and low-drag airfoil finally led to the double delta planform with low aspect ratio, a wing shape which at that time represented an entirely new departure. The aerodynamicists' calculations had already shown that this wing configuration offers a number of advantages: the sharply swept inboard wing produces the minimum drag at supersonic speeds, while the moderately swept outer wings improve flying qualities in the subsonic range, in particular stability at low speeds. The air intakes for the engine were easy to accommodate in the leading edge of the inner wings, where they are still within the region of accelerated flow, produce little external drag and ensure adequate air mass flow throughout the speed range. The double delta wing combines a relatively large wing area with a low thickness/chord ratio. This gives low wing loadings and hence short take-off and landing distances on the one hand, and good flying qualities in the supersonic range on the other.

Promising as were the theoretical calculations, practical experience was entirely lacking. To supply this lack and to test flying qualities at subsonic speeds, the Saab 210 research aircraft was built in 1950, with dimensions roughly half those of the later *Draken*. In addition Saab constructed its own wind tunnel for transonic measurements. Further tests in American wind tunnels rounded off the results. Much of the work was in the nature of pure basic research, and many of the problems had to be tackled simultaneously by several different methods. However, progress was rapid, and by 1952, when the double delta wing was finally decided upon, the manufacturers could call on not only a complete theoretical picture of its aerodynamics in the speed range of interest, but also on extensive basic data for strength calculations and aero-elastic behaviour. This solid background had been built up thanks to close cooperation between aircraft industry, Aeronautical Research Establishment (FFA), universities and aviation authorities. Cooperation went so far that certain departments of these organizations—together with the engine and equipment industry—formed a single research community. Within the Swedish aircraft industry there is practically only one company for each kind of task, so that there is no risk of the sort of rivalry which inevitably leads to wasted effort. Last but not least, a highly developed documentation service is available to evaluate all relevant writings, no matter what the language in which they are composed.

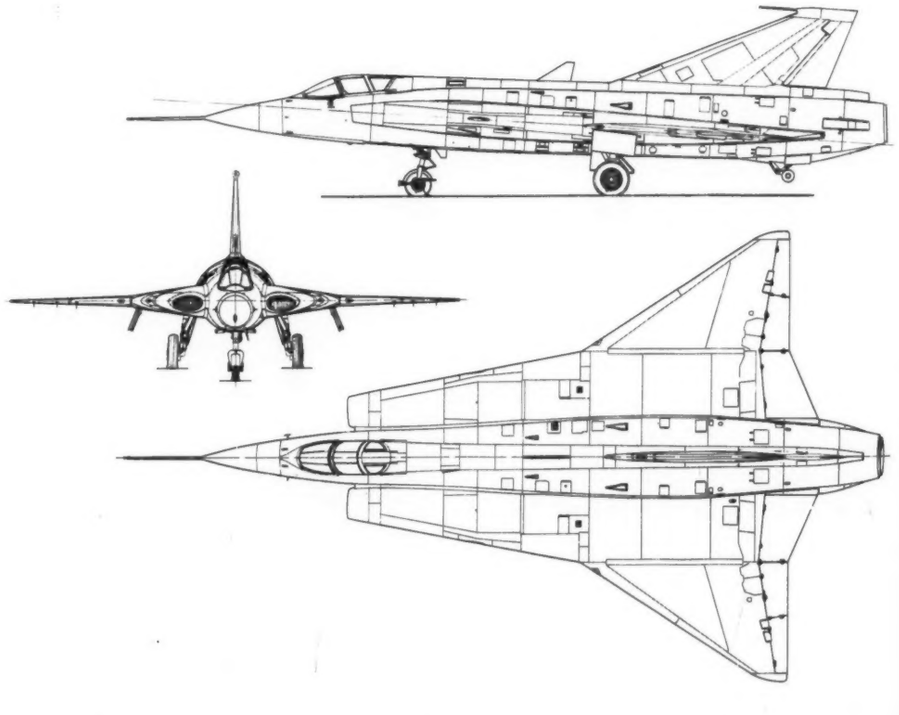
In 1953 Saab received a contract to build three prototypes. The first began flight testing on October 25th, 1955, and subsequent events fully con-

Main data for the Draken J35B

Wing span	30 ft 10 in.
Length including probe	51 ft 10 in.
Height	12 ft 10 in.
Wing area	538 sq.ft.
Aspect ratio	1.77
Leading edge sweep, inner	80°
Leading edge sweep, outer	57°
Take-off weight	17,600—19,800 lb
Engine: 1 Rolls-Royce RB.146 (built by Svenska Flygmotor AB under licence) with Swedish afterburner. Static thrust without afterburner 13,200 lb (according to British sources).	
Maximum speed in stratosphere	Mach 2+
Sea level rate of climb	50,000 ft/min
Landing speed	116 knots
Landing roll with brake 'chute	approx. 2,000 ft

Armament (in various combinations):

2 automatic cannon, calibre 30 mm
2 rocket launchers, each with 19 unguided rockets, calibre 3 in.
4 air-to-air guided missiles, e. g., *Sidewinder*
18 unguided air-to-surface missiles, calibre 5.3 in.
9 220-lb bombs
4 550-lb bombs
2 1,100-lb bombs
1 air-to-surface guided missile
4 auxiliary fuel tanks



firmed the results of the theoretical investigations and model tests. Confident of the quality of their design, the Saab factories shortly afterwards began purchasing tools and constructing jigs, so that production could begin immediately on receipt of a firm order in August 1956.

Ease of manufacture

Compared with its predecessors, the *Flying Barrel* and the *Lansen*, the *Draken* does, of course, make greater demands on manufacturing resources, though Saab still describes it as an easy aircraft to produce by modern standards. The *Draken* and its sub-assemblies are described in terms of mathematical coordinates, which in turn serve as basis for the tooling. Manufacturing tolerances are determined not only by aerodynamic requirements, but also by the need for absolute interchangeability. No modifications are made during the production run to jigs, tools or an individual component without appropriate amendments being made to all relevant documents. All processes are set down in written instructions. This facilitates collaboration with sub-contractors and goes a long way towards guaranteeing unchanging quality.

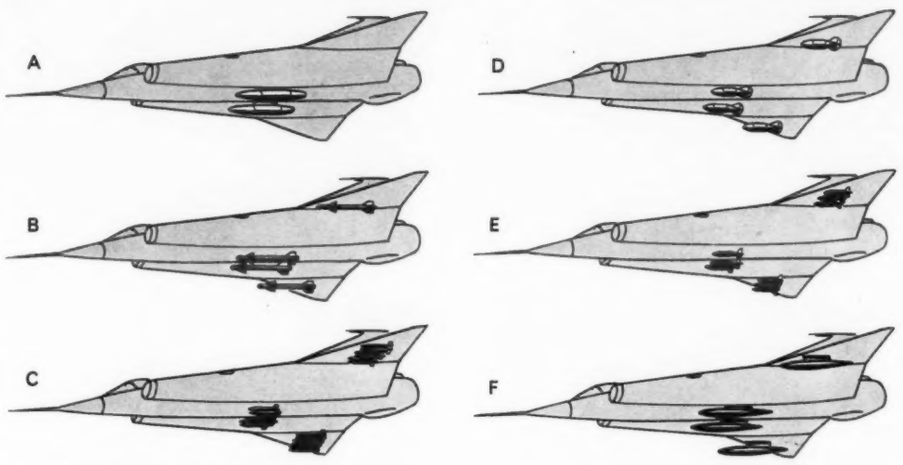
In dividing the aircraft into sub-assemblies, particular attention has been given to good accessibility for overhauls and repairs. The inner wing forms a single sub-assembly with the fuselage and, despite its thickness/chord ratio of only 5 percent, provides accommodation for the undercarriage, the main fuel tanks and the cannon with their ammunition. The outer wing triangles are attached by means of bolts. Thanks to the use of standardized light metal alloys whose handling qualities have been well proven in practical application, only few special machines and processes are required. And most of these were developed by the Saab people themselves, such as for example a milling machine to fashion flanges with varying thicknesses and angles for the main fuselage bulkheads. Saab makes extensive use of metal bonding, thus obtaining high strength with minimum weight without having recourse to the costly methods of integral forming or chemical milling. In most cases the well-proven rubber press suffices for sheet metal shaping. Welded structures, which demand considerable work, have been dispensed with in favour of light metal castings, and parts of the wing skin consist of honeycomb sandwich plates.

Powerplant

The powerplant chosen for the *Draken J35A* is the Rolls-Royce *Avon Series 200*, which is manufactured under licence by Svenska Flygmotor AB. The afterburner was developed in Sweden itself[1]. Points in favour of the *Avon* are that it is already familiar to the Air Force from the Hawker *Hunter*, and that it also powers the Sud-Aviation *Caravelles* operated by SAS. Hence there was already a nucleus of trained maintenance personnel, and the question of spares would be easier to handle. The *Avon* in the J35A develops a static thrust of roughly 11,000 lb, or around 15,400 lb with reheat, which enables the J35A to reach speeds of Mach 1.8 at 36,000 ft. A newer version of the *Draken*, the Saab J35B, will be powered by the Rolls-Royce RB.146, also built by Svenska Flygmotor; according to British sources this engine has a static thrust of 13,200 lb. Later models of the J35A series will also have a longer fuselage, to reduce drag at supersonic speeds. The new afterburner developed for the J35B occupies the whole of the larger fuselage rear. No thrust figures have yet been released, but it is known that the J35B exceeds twice the speed of sound in the stratosphere and climbs at a rate of 50,000 ft/min at sea level.

To avoid overstretching its capabilities, Sweden has decided not to develop its own high-power jet engines for the time being, although a very promising beginning had been made in this direction in the early 50s. There is no doubt, however, that the Swedish industry, should it ever be isolated by an armed conflict between the Great Powers, would be perfectly capable of making itself independent in the aircraft engine field too.

[1] See "Afterburner Design and Development in Sweden," in *Interavia* No. 1, 1959, pp. 76-78.

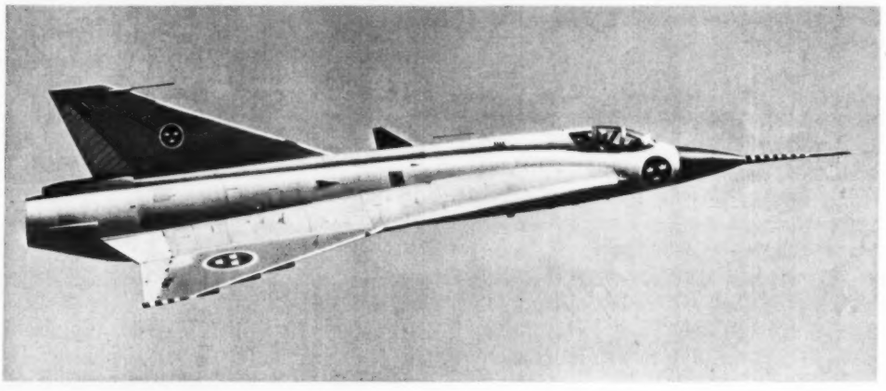


Some typical combinations of external loads

A. Two 1,100-lb bombs or two rocket launchers each with 19 3-inch rockets; B. Four *Sidewinder* air-to-air missiles; C. Eighteen 5.3-inch rockets; D. Four 550-lb bombs; E. Nine 220-lb bombs; F. Four jettisonable fuel tanks.

Winter trials in Northern Sweden.

Above, two J35As, in service with Fighter Squadron F13 at Norrköping. Powered by a SFA RM.6 jet (licence version of the Rolls-Royce *Avon Series 200*) plus a Swedish afterburner, the J35A reaches Mach 1.8 and climbs at nearly 40,000 ft/min from sea level. Below, the J35B with more powerful engine (licence model of the Rolls-Royce RB.146) and new afterburner. Max. speed Mach 2+; initial rate of climb roughly 50,000 ft/min.



Aircraft systems

All vital control systems in the *Draken* are hydraulically operated: elevator/ailerons, rudder, air brakes, undercarriage (retraction and lowering, steering of nose wheel). The hydraulic system consists of two parallel and entirely independent circuits, each of which would be sufficient to actuate the control surfaces. The two pumps, also independent, are driven by the jet engine and deliver a pressure of 3,000 p.s.i. One of the two hydraulic circuits also contains a reserve pump which takes its power from a ram air turbine lowered into the air flow beneath the fuselage. The movements of the control column and pedals are passed by cables to servo valves, which in turn actuate the control surface servos. The control cables thus had to be designed only for light forces. Control feel is simulated in the actual controls in the cockpit.

The undercarriage in the first production models of the *Draken* consists merely of a nose wheel and two main wheels. Later models of the J35A and all J35Bs, however, have an additional retractable twin tail-wheel, to permit of landings with high angle of attack. The aircraft's increased air drag then reduces the landing run. The whole undercarriage is retracted within four seconds: the nose wheel folds forwards, and the main wheels swing outwards into the wings, the sprung legs telescoping as they go. The double disc brakes for the main wheels are equipped with anti-skid devices. With wheel and parachute braking, the *Draken* rolls for an average of 2,000 ft after touchdown, though it has also been brought to a standstill within 1,300 ft on some occasions. Without brake parachute the landing run is roughly 4,000 ft. Landing speed is given as 116 knots. The Swedish Air Force insisted most particularly on good landing qualities, so that the *Draken* could be operated from small airfields. Several straight stretches of motor road have also been widened, to serve as additional landing strips.

These 5.3-inch rockets were developed by AB Bofors (Sweden) for use against ground targets. The *Draken* can carry up to 18 of them beneath its fuselage and wings.

The Saab J35C two-seat trainer version of the *Draken* is identical in essentials to the J35A. By simplifying the equipment, room has been made for the lengthened cockpit. The J35C also has a lower fuselage nose to improve visibility, but this can readily be exchanged against the nose of the J35A.

The fuel system, too, is in two sections, each of which incorporates a collector tank (also used during inverted flight) and an electrical pump. Up to four slip tanks can also be carried underneath the fuselage and wings. Compressed air bled from the engine compressor via a pressure reducing valve forces the fuel out of the individual tanks into the collector tank, with the foremost tank being emptied first and so on back to the collector tank. The aircraft's centre of gravity therefore travels first backwards, into the optimum position for supersonic flight, and then forwards again, into the best position for slow flight.

The standard electronic equipment for the *Draken J35B* was designed as a component of the STRIL 60 semi-automatic warning and control system, now under construction. Advanced radar stations report all aircraft approaching Swedish territory to a central control station, where data such as position, speed, direction and altitude are evaluated in computers and stored in a memory. At the same time the general situation in the air is displayed optically. On the basis of this information, the operational commanders decide on the defensive action to be taken and issue take-off orders to the fighter squadrons stationed throughout the country. Other services (tank units, anti-aircraft, warships, etc.) will also be controlled from the STRIL 60 centres. Before the aircraft can pick up the enemy on their radar, they must be guided towards him from the ground. It therefore seems logical that a considerable portion of the *Draken's* electronic system—at any rate in the standard version destined for the Swedish Air Force—should be designed for data reception and evaluation. Other navigation aids in the J35B: a gyro platform, an air data indicator, a three-axis flight director, a combined navigation and landing system, two voice radios, and an autopilot which also provides pitch and yaw damping. This is particularly valuable in ensuring that the *Draken* should be a stable firing platform. Pilots say that the damping works so well that the passage through the sound barrier is not heralded by any form of buffeting, but can merely be read from the Machmeter.

The electronic division of Saab has developed for the J35B a collision course fire control system, designated Saab S7, with the aid of which the *Draken* can attack even an enemy with higher speed. The sighting head displays the target, sighting line and the aircraft's position. Data are handled by an analogue computer connected to the a.c. network (400 c/s). The Saab S7 is designed primarily for use against aerial targets, but can also be employed for attacks on ground targets. Altogether the Swedish Air Force requires that the *Draken* be suitable above all for air combat, since

it already has a high-quality ground attack aircraft in the *Lansen*.

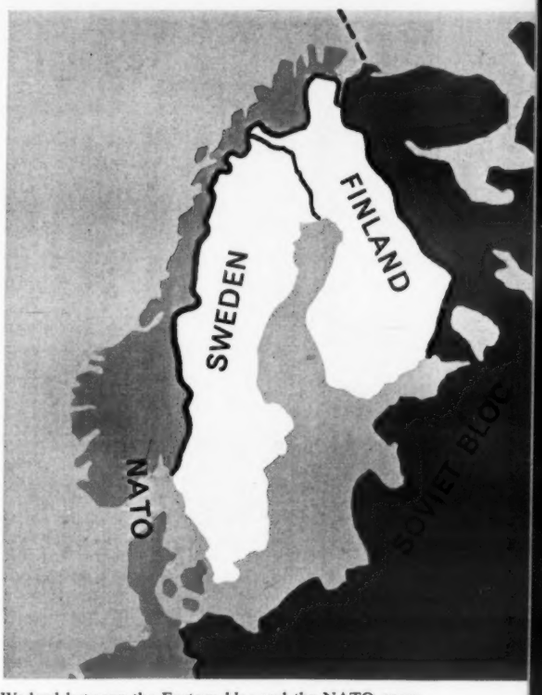
The autopilot, gyro platform and air data computer are also considered as standard equipment for the export version. The remaining electronic equipment, however, can be chosen within wide limits to meet customers' requirements. Instrument panel and switch consoles have also been designed in such a way that the most varied navigation and fire control systems can be fitted. In this way, the *Draken* can use the Ferranti AIRPASS II, Hughes TARAN or North American Super NASARR systems, for example. All these provide the following operating modes: map painting, terrain avoidance, profile flying, search and tracking of aerial targets. In addition they can be combined with other elements, such as gyro platforms, air data computers, flight directors and computers, to form fully automatic fire control and bombing systems.

There is no need to stress that only high-grade flying qualities in the "carrier aircraft" enable the best to be obtained from these advanced systems. Results so far attained in test flying give every reason to suppose that the *Draken* does have these qualities. It can be flown at low altitude along narrow winding valleys and operated from small mountain-ringed airfields, as a series of tests in the Swiss Alps has proved. Even at take-off speed it can be put into a tight turn, with a radius varying between 1,650 and 1,800 ft depending on take-off weight. In a tight turn at low speed, the low aspect ratio considerably increases drag, a phenomenon which is willingly used by the pilots to cut down their speed rapidly before landing. Unlike straight or swept wings, the delta does not suddenly lose its lift at a given angle of incidence, but can be stalled without danger. The *Draken* has been flown with full controllability at an angle of incidence of 30 degrees and down to a speed of 95 knots. Landing speed, as already mentioned, is around 116 knots, so that even inexperienced pilots run little risk of dropping a wing. Under extreme conditions it can be spun, and reportedly recovers as easily as a trainer.

As all the main masses are concentrated near the aircraft longitudinal axis, it is not surprising that the roll speed should be unusually high, in the neighbourhood of 300 degrees per second. At altitude, load factors of six to seven are possible without any signs of unpleasant control difficulties or instability.

As regards armament, too, Saab has left customers considerable leeway. Standard armament consists merely of two 30-mm cannon mounted in the inner wing sections—and even these can be exchanged for fuel tanks. The other weapons are suspended in various combinations underneath the fuselage and wings: e.g., four *Sidewinder* air-to-air missiles or 18 air-to-surface missiles (5.3 in.). The weapon combinations recommended by Saab suggest that the J35B can carry some 2,200 lb of external loads: nine 220-lb bombs, or two 1,100-lb bombs, or two rocket launchers each with 19 air-to-air rockets (3-inch), etc. Provision is also made for use of air-to-surface missiles of Swedish design; presumably these will be a variant of the *Robot 304* developed jointly by the Robotbyrån and the Swedish Armed Forces Research Establishment.

For pilot training a series of two-seat J35Cs and Curtiss-Wright simulators is being provided. The J35C is almost identical to the J35A in structure and performance. Its equipment, however, has been simplified in order to make room for a second, rear seat, which is placed slightly higher than the forward (student's) seat. The J35C also has a lower nose and two Saab ejection seats. The simulators can be used to "fly" complete combat missions, including use of weapons. The movements of the simulator cockpit reproduce all the accelerations occurring in real flight, and the illusion of flying is completed by vibrations, the noise produced by air flow, engines and radio equipment, by gusts and by the buffeting caused by icing.



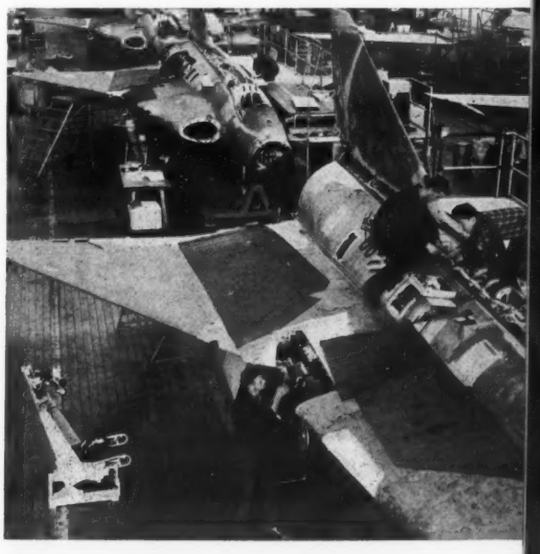
Wedged between the Eastern *bloc* and the NATO countries, Sweden consistently follows a policy of non-alliance and entrusts its national security primarily to a hard-hitting Air Force. Finland is also a neutral country, but is linked by treaty to the Soviet Union.

*

Sweden feels itself secure under the protection of its fighter squadrons, which are in the process of converting to *Drakens*. The nation looks to its Air Force with pride, but hopes that it will never have to use it in earnest. ⟡

A J35B equipped for ground strike missions. Underneath each wing are six 5.3-inch rockets, and under the fuselage one rocket launcher, developed jointly by Saab and Malmö Flygindustri, for 19 air-to-air rockets (3-inch). The nose portion of this container is automatically blown off just before the rockets are launched. The twin tail-wheel—not fitted in the earliest J35As—enables landings to be made with a large angle of incidence, in which the aircraft drag acts as braking aid.

The *Draken* in production at Linköping.



What's in the Air?

INDUSTRY

Employment in the U.S. aircraft industry is steadily declining. Total labour force in April 1960 was some 667,700 persons, according to Bureau of Labor Statistics, or some 200,000 below the highest level reported since the war, namely 861,700 in 1957. The composition of the labour force is also changing. Whereas in 1952 the proportion of production workers amounted to 73 percent of the total, it is today only 60 percent. In the Los Angeles area employment in the aerospace industry has fallen by 21,700 since June 1959.

North American Aviation's B-70 Mach-3 bomber programme has been allocated $75 million to be spent entirely on the vehicle itself, with the balance of the $365 million appropriated for fiscal 1961 to be used in developing the 18 major sub-systems. Company officials have indicated that they do not expect the early release of the balance of development funds by the Air Force. The General Electric J93 engine for this aircraft is now undergoing first flight tests slung beneath a B-58 bomber (see picture).

The U.S. Air Force's Dyna Soar rocket glider development programme is expected to be stepped up within the very near future. Invitations will be requested by Boeing Airplane Co. for about one dozen sub-systems. The *Dyna Soar* is at present scheduled for its first flight test in August 1963, in a launching from a B-52. First *Titan* launching of an unmanned vehicle is scheduled for November 1963, with the first manned flight scheduled for September 1964.

Douglas Aircraft Co., of Santa Monica, Calif., has been appointed by the U.S. Navy as designer and contractor for the new *Missileer* aircraft to serve as a launching platform for the Bendix/Grumman *Eagle* long-range air-to-air missile. The cost of developing the entire weapons system, including aircraft and missile etc., is estimated at no less than $3,400 million. The *Missileer* will be a comparatively slow twin-engine jet designed for long endurance, and powered by TF30-P-2 turbofans being developed by Pratt & Whitney.

Management changes at Douglas: Edward H. Heinemann, Vice President Engineering—Combat Aircraft Systems, who had been appointed to replace M. E. Oliveau as head of the European Office in Geneva, has resigned to become Executive Vice President of Summers Gyroscope Co., Santa Monica. A. E. Raymond, formerly Douglas Vice President in charge of Engineering, has joined the Rand Corporation as a consultant, and J. W. Clyne, who resigned as Director of International Commercial and Military Sales in June, is now with United Aircraft. George Romney, President of American Motors Corp., has been elected a member of the Douglas Board.

New President of Grumman Aircraft Engineering Corporation, following the death of Leon A. Swirbul, is E. Clinton Towl, one of the company's founders and Vice President since 1954.

The last Canadair CL-28 Argus anti-submarine aircraft built for the Royal Canadian Air Force came off the assembly line in mid-July. Canadair's total contract for the 33 CL-28s amounted to approximately $170 million, including spares, modifications to early aircraft and RCAF technical training.

Précilec S. A., of Paris, has signed a new agreement with *United Aircraft Corporation* extending the terms of the 1956 agreement with Norden-Ketay, today a subsidiary of United Aircraft. The new arrangement covers the whole present and future range of the Norden Division products, and provides for a wide exchange of technical knowledge and reciprocal research and development experience. United Aircraft has now acquired a 20 percent holding in the increased Précilec capital. The French company has been granted an exclusive general licence for France and the French Community, and non-exclusive rights for the Common Market countries plus Austria, Portugal, Spain and Switzerland.

Société d'Etudes et de Fabrications Aéronautiques has received an order for parachutes from the Italian Ministry of Defence (Air). This follows an earlier order for EFA parachutes from the Italian Aero Club for its special section.

Richard Fairey, son of the founder of Fairey Company, died in Cannes on July 26th, at the age of 43. He had retired from the Fairey Board on the urgent advice of his doctors at the end of June 1960.

Royal Netherlands Aircraft Factories Fokker has announced an interest in projects concerning the design, development and production of military STOL and VTOL combat aircraft, under NATO specifications. In preparing a design for such an aircraft Fokker would be able to draw on the know-how of Republic Aviation Corporation, with whom a far-reaching cooperation agreement was signed in March this year. Fokker feels that a STOL or VTOL project should be handled in the same way as the Breguet *Atlantic* maritime patrol aircraft.

The 4th European Aviation Congress will be held in Cologne, Germany, from September 18th to 22nd, taking the place of the 1960 Annual Meeting of the Wissenschaftliche Gesellschaft für Luftfahrt. The following main themes are on the provisional agenda: STOL aircraft, sailplanes and light aircraft, aerodynamics and the mechanics of flight, strength problems, engines, noise abatement and autonomous navigation.

The 24th Paris Air Show will be held at Le Bourget from May 26th to June 4th, 1961. Major flying displays will be staged on Saturday and Sunday, June 3rd and 4th.

The West German Air Show will in future be held every second year, alternating with the Paris Air Show. The location will continue to be Hanover-Langenhagen Airport, and the show will be timed to coincide with the annual Hanover Trade Fair. The next date will be April 1962.

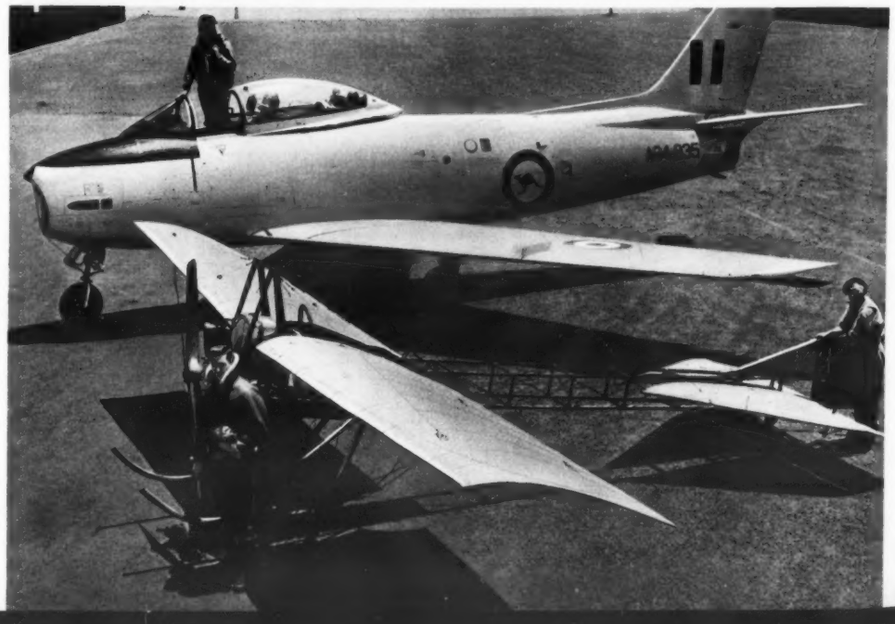
MILITARY AFFAIRS

The first ten Lockheed F-104F two-seat trainers of the 30 on order from the United States for the West Ger-

Professor Bock, Chairman of Germany's Wissenschaftliche Gesellschaft für Luftfahrt (Society of the Aviation Sciences), presents the 1960 Ludwig Prandtl Ring for outstanding achievements in the aerodynamic field to Sir Frederick Handley Page.

◀ *Misrair's first de Havilland* Comet 4C *arrives at London Airport on its inaugural flight from Cairo.*

Fifty years in Australian aviation, from the wire-and-canvas Deperdussin in the foreground to the Australian-built Avon-Sabre *jet fighter in the rear. The Deperdussin, one of two which were used at the Central Flying School in 1914, is now kept in the RAAF Museum at Point Cook, Victoria.*



man Air Force have been delivered. On July 22nd, 1960 eight were officially handed over to the staff of No. 10 Waffenschule (Oldenburg) at the Nörvenich Military Base; the aircraft will continue to be based at Nörvenich, because runway length at Oldenburg is inadequate for training purposes. The other two F-104Fs are based at Kaufbeuren for training technical personnel. The F-104Fs are transported unassembled to Europe by ship, and are then assembled at Nörvenich by Lockheed and Messerschmitt technicians, working with West German and U.S. Air Force personnel.

France's new aircraft carrier "Foch" was launched at the Brest Naval Base on July 23rd, and is now moored alongside the "Clemenceau" for completion and arming. On the same day work was started on a helicopter cruiser to replace the training cruiser "Jeanne d'Arc"; the new cruiser is to have some surface-to-air

Peter Twiss, *former Chief Test Pilot of Fairey Aviation, who set a world speed record of 1,132 m.p.h. in the Fairey Delta 2 in 1956, has retired to take over responsibility for sales of Fairey Marine motor-boats.*

weapons in place of the conventional 100-mm armament. The "Foch" has a displacement of 30,000 tons and a beam of 151 ft; max. speed 32 knots; max. power 120,000 h.p. Equipment includes a canted deck, mirror landing system and two steam launching catapults. Aircraft complement will include one interceptor and strike squadron *(Etendard IV)*, one anti-submarine unit (Breguet *Alizé*) and one all-weather fighter squadron (Sud-Aviation *Aquilon*).

Norwegian Air Force pilots will continue to be trained in Canada for a further four years, under an extension of the agreement with the Canadian External Affairs Department. The programme is part of Canada's contribution to NATO, and covers the training of 30 Norwegian pilots and three navigators per year.

AIR TRANSPORTATION

United Air Lines and Capital Airlines have announced that they plan to merge, subject to CAB and stockholder approval. The plan is already approved by Vickers-Armstrongs, who holds a $33.8 million mortgage on Capital's *Viscount* airliners. Capital shareholders will be offered one share of UAL common stock and a five-year warrant to purchase 1.5 shares of United stock at $40 per share, for each seven shares of Capital common stock. Not less than 85 percent of the $12 million Capital debentures must be deposited for exchange.

United President W. A. Patterson has said that his company is putting $28.8 million cash into the deal and will retain 41 of Capital's *Viscounts*. It is estimated that the transaction will involve a loss of about $9 million for Vickers, who will take back 15 of the *Viscounts*. Vickers' outstanding mortgages against Capital assets will be secured with $15.9 million worth of par value 5.5 percent cumulative preferred United stock, 60,000 shares of United common stock, and 7½-year warrants to purchase 200,000 shares of United common stock at $45 per share.

Stockholders of both airlines are to vote on the merger by the end of October, and CAB should reach a decision by February 1961.

The Independent Airlines Association, an organization of 21 U.S. airlines, has filed a plan with CAB for two-week trans-Atlantic charter flights for as low as $222 round trip, to be operated by some member carriers from September 1st, 1960. The $222 figure is based on a charter price of $21,978 for a four-engine *Constellation* carrying 99 passengers; charter prices generally range upwards from $260 per person, and economy-

The Sud-Aviation Alouette *helicopter is at home in all environments. Above,* Alouette III *and* II *on altitude tests in the Mont Blanc massif. Below, an* Alouette II *helping to construct an air conditioning plant on the roof of a building at Saint Cloud, near Paris. The work was completed in 1½ hours, compared with 8 days by conventional methods.*

class fares on scheduled trans-Atlantic flights are over $400 per round trip. The new plan will apply to members of clubs which qualify under CAB rules and will cover flights between New York and London, Paris, Amsterdam, Geneva and Frankfurt.

The Civil Aeronautics Board has ordered *Pan American World Airways* and *National Airlines* to nullify the financial phase of a 1958 agreement covering an exchange of stock and the leasing of jet airliners between the two carriers. CAB rules that the exchange of 400,000 shares between the companies and the Pan Am option to purchase an additional 250,000 National shares would give Pan Am control of National. The ruling does not affect the aircraft leasing programme, under which Pan Am borrows National jets during the summer for European flights, and National borrows Pan Am jets during the winter for its New York–Miami service.

United Air Lines has reached preliminary agreement with Boeing Airplane Co. for the purchase of a further eleven Boeing 720 medium-range jet transports at a price of approximately $45 million. A formal contract was due to be signed on September 1st, 1960, and deliveries are scheduled for 1963. United has already ordered 18 Boeing 720s, now in course of delivery. An early decision is also expected on a projected order for forty Boeing 727 short-haul jets (Boeing is also negotiating an order with Eastern Air Lines, and a firm decision to put the aircraft in production will clearly depend on at least two major U.S. orders.)

Air France recorded an 8 percent increase in total tonne-km performed during 1959, while passenger-km figures were up 9 percent. Overall load factor was 67 percent against 66 percent in 1958. Gross revenues, excluding a state subsidy of 2,926 million old francs ($5.8 million), totalled 105,800 million ($211.6 million), with operating revenues at 92,200 million ($184.4 million), compared with 87,200 million ($174.4 million) and 75,200 million ($150.4 million) respectively the year before. Expenditure was up from 91,200 million ($182.4 million) in 1958 to 108,900 million ($217.6 million) in 1959.

British Overseas Airways Corporation closed the 1959–60 financial year on March 31st, 1960 with an overall deficit of £833,795, thanks to the loss of £1,111,608 incurred by the associated companies. BOAC's own operations earned a profit of £277,813. Capacity of-

A Convair B-58 Hustler *supersonic bomber has been equipped with a special nacelle beneath the fuselage, to permit the flight testing of a General Electric J93 engine. Six of these engines are to power the North American B-70* Valkyrie *Mach-3 bomber.*

Dassault MD.410 Spirale *multi-purpose aircraft, with Turboméca* Bastan *turboprops (approx. 1,000 h.p. each). The aircraft will be operated at a gross weight of around 6 tons and thanks to its low-pressure tyres can utilize semi-prepared runways, since its take-off and landing runs are no more than 650 to 800 ft. Armament consists of two cannon, one on either side of the forward fuselage, plus light fragmentation bombs, air-to-air rockets or missiles for ground attack missions. Picture shows the* Spirale *with four MATRA 361 rocket launchers beneath the wings.*

The HA.P-300 experimental glider (works designation HA. 23P) built by Hispano Aviación at Seville is about to begin flight testing. The delta-wing model (leading edge sweep 57.5°) is to be used to accumulate experience in preparation for construction of a lightweight multi-purpose combat aircraft (with Bristol Orpheus).

Partenavia P.19 mixed construction, two-seat sports aircraft, designed for one engine in the 80 to 100 h.p. power class (83 h.p. Agusta GA.70/0 or 95 h.p. Continental C.90). The P.19 was shown for the first time at the sports aircraft display held at Venice Lido from July 7th to 10th, 1960, and has been chosen as a standard aircraft for the Italian aero clubs.

Also destined for the Italian aero clubs is the two-seat Partenavia P.59, which can be supplied in two versions, with fixed tail-wheel or fixed nose-wheel undercarriage. Engine: 95 h.p. Continental C.90-12F.

fered rose by 25 percent over the previous year, and the airline's own operating revenue by 22 percent. For the first time more than half a million passengers were carried (587,372). Operating costs are about 6 pence a ton-mile less than three years ago, and break-even load factor is down to 55 percent compared with 60 percent the previous year and 63 percent three years ago.

Deutsche Lufthansa's profit and loss account for 1959 shows earnings of DM 223.2 million and expenditures of DM 258.3 million (DM 1 million = $238,200), resulting in a deficit of DM 36.1 million, as compared with a deficit of DM 32.1 million in 1958. Receipts per tonne-kilometre performed were DM 1.13, roughly the same as the previous year, while operating costs were DM 1.31 per tonne-kilometre.

Union Aéromaritime de Transport and Transports Aériens Intercontinentaux, the two French independent operators, have published a joint timetable for Douglas DC-8 jet services to Africa, to come into force on September 10th. From that date there will be regular jet services to seven African cities.

The Franco-Pakistani air agreement, which dates back to 1950, has been amended to permit Air France and Transports Aériens Intercontinentaux to run four jet services weekly to Karachi, with a fixed annual quota of passengers in the east-west direction. The amendment also provides for certain restrictions on French operations in favour of Pakistan International Airlines.

Austrian Airlines' six Vickers *Viscounts,* ordered and paid for by the State, have now been handed over to the airline free of charge. The Austrian Cabinet has also decided to exempt the company from payments due against State credits totalling 120 million schillings ($4.7 million). Total value of these aircraft, plus spares, is given as 260 million schillings ($10.2 million).

Alitalia, the Italian flag carrier, inaugurated three weekly *Caravelle* services on the route Rome–Athens–Cairo at the end of July. This is the company's first scheduled service to Cairo since the Suez affair in November 1956.

Middle East Airlines is sending a group of 23 captains and officers to the United Kingdom for conversion training to *Comets.* MEA has four *Comet 4Cs* on order (with an option on a fifth) for delivery beginning late this year, and plans to introduce them into service in January on the Beirut–Vienna–Frankfurt–London, Beirut–Athens–Geneva–London, Beirut–Rome–London and Beirut–Rome–Madrid–Lisbon routes. MEA reports that passenger volume during the first half of 1960 was up 14 percent on the corresponding period for 1959. Daily utilization of the carrier's fleet of seven *Viscounts* is steadily increasing and averaged almost ten hours a day in June this year.

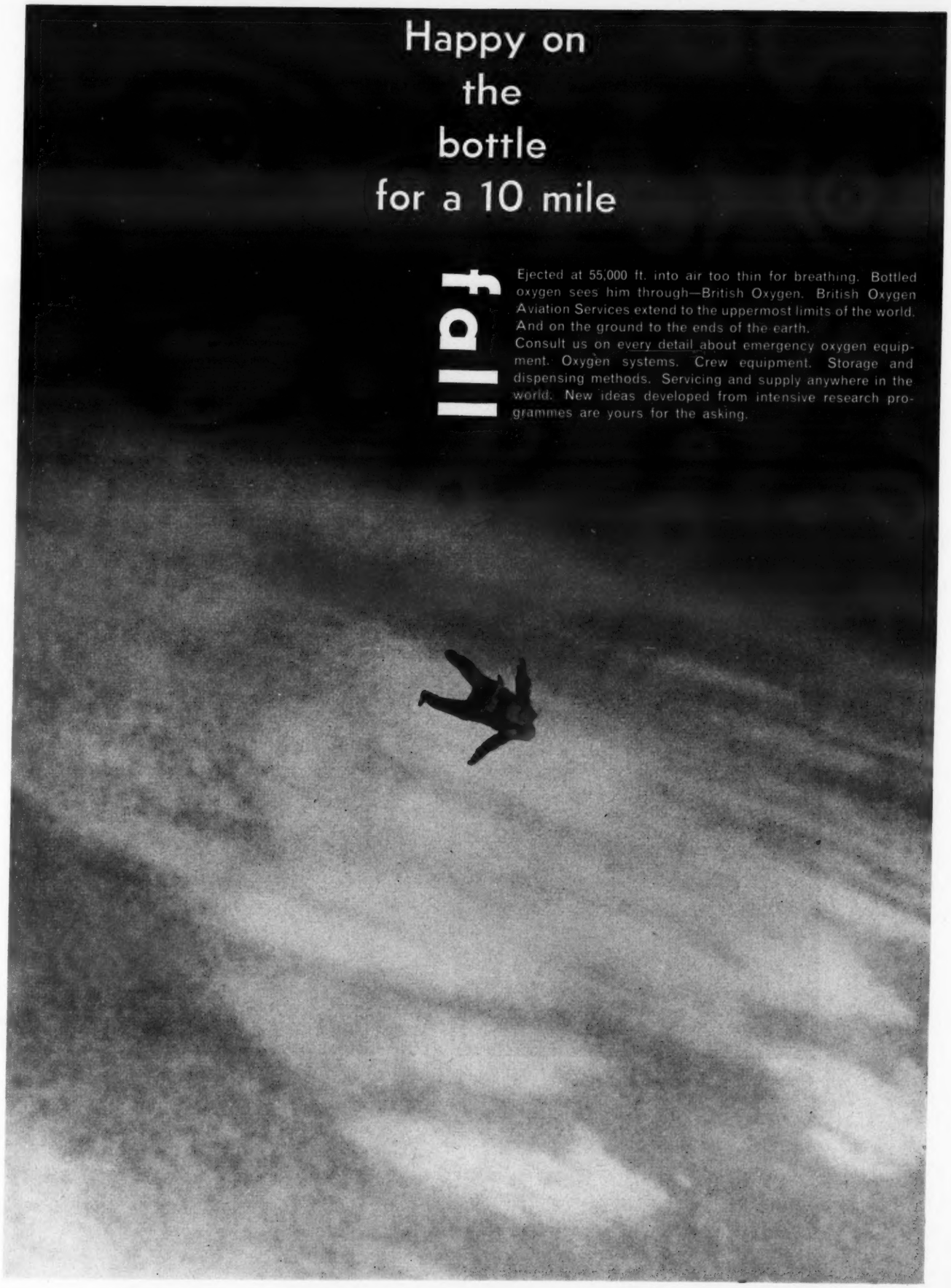
Hartwell Aviation Supply Company, of Los Angeles, California, is the distributor of a textile product manufactured by American Velcro Inc. This can be used as a fastener without the need for seams, nails, press-studs, zip fasteners or other means of attachment; it has been employed for some years for the most varied industrial applications. Velcro, which is the invention of a Swiss, Georges de Mestral, works on the same principle as burdock burrs, which cling when brought into contact with clothing or hair. When an area is covered with a velvet-pile material with a surface of soft loops, and a second piece of material covered with a dense layer of small hooks is lightly pressed over it, the two surfaces stick fast and will not separate again unless pulled in a certain direction. The inventor has patented his product under the name Velcro *(Vel = velvet, cro = crochet—French for "hook"). The adhesive surfaces are not applied to the entire area of the material (seat covers, carpets, etc.) but only to narrow edges. The strips are available in the following widths: ⅝ inch, ¾ inch, 1 inch, 1¼ inch and 2 inches. Picture here shows a seat cover using Velcro strips in a National Airlines Lockheed* Electra.

Wooden mockup of the twin-jet business aircraft projected by Bedek Aircraft, of Lod Airport, near Tel Aviv. Designed primarily for export, the new model (Turboméca or Continental engines?) will have a cruising speed of around 400 knots, a take-off distance of 2,600 ft and a range of up to 1,400 nautical miles.

Iraqi Airways still has not been able to decide on the best type of airliner to buy to meet its future requirements. The Technical Committee formed some months ago to evaluate the aircraft available has been dissolved, following the resignation of the Chairman (Chief of Air Staff Brigadier Awkati) who is reported to have favoured the Russian Il-18 against the views of the Committee majority. Some opinions favour buying jets for prestige reasons, to compete with Misrair and MEA who have ordered de Havilland *Comets,* but there is doubt whether Iraqi Airways is technically and operationally capable of maintaining and operating larger aircraft. Whatever the ultimate decision, which will have to be made this year, some 2.5 million dinars ($7 million) are to be spent on new equipment.

The first unit of the SATCO system (Signaal Automatic Air Traffic Control) has been handed over to Amsterdam's Schiphol Airport by the manufacturers, N.V. Hollandse Signaalapparaten. The unit, which is a computer for the automatic evaluation of flight data, can be used independently of the rest of the system. The remaining units—the automatic radar and transmission equipment—are to be placed in service in the course of the next two years.

Happy on the bottle for a 10 mile fall



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BOC

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All human speech is made up of hisses and buzzes.

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These impulses or digital "bits" are then transmitted at high speeds. At the receiving end, the Vocoder puts them back together. What you say comes out in an artificial voice.

Privacy is an important by-product of this process. The message in transmission is actually in code. Only another Vocoder can unscramble the message. The Vocoder is thus an important communications tool for military and defense work.

Another Vocoder model, built on the analog principle, sends several messages side by side. By squeezing speech, a telephone wire can carry 5 or 6 times as many simultaneous conversations. In radio and wire line communications, the Vocoder can send a number of messages on one conventional voice channel without any station overlapping.

Vocoder is one more example of the creative engineering capability of the 5,000 engineers and scientists who staff Hughes Aircraft Co. laboratories. Their activities cover virtually every area where modern electronics can serve man.

Other products include a full range of semiconductors—transistors, diodes, rectifiers; storage tubes, precision crystal filters, microwave tubes, special instruments and complete industrial systems.

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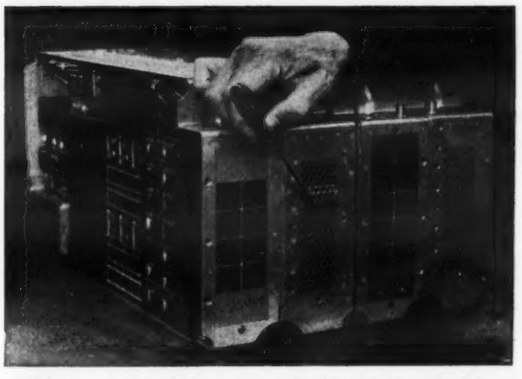

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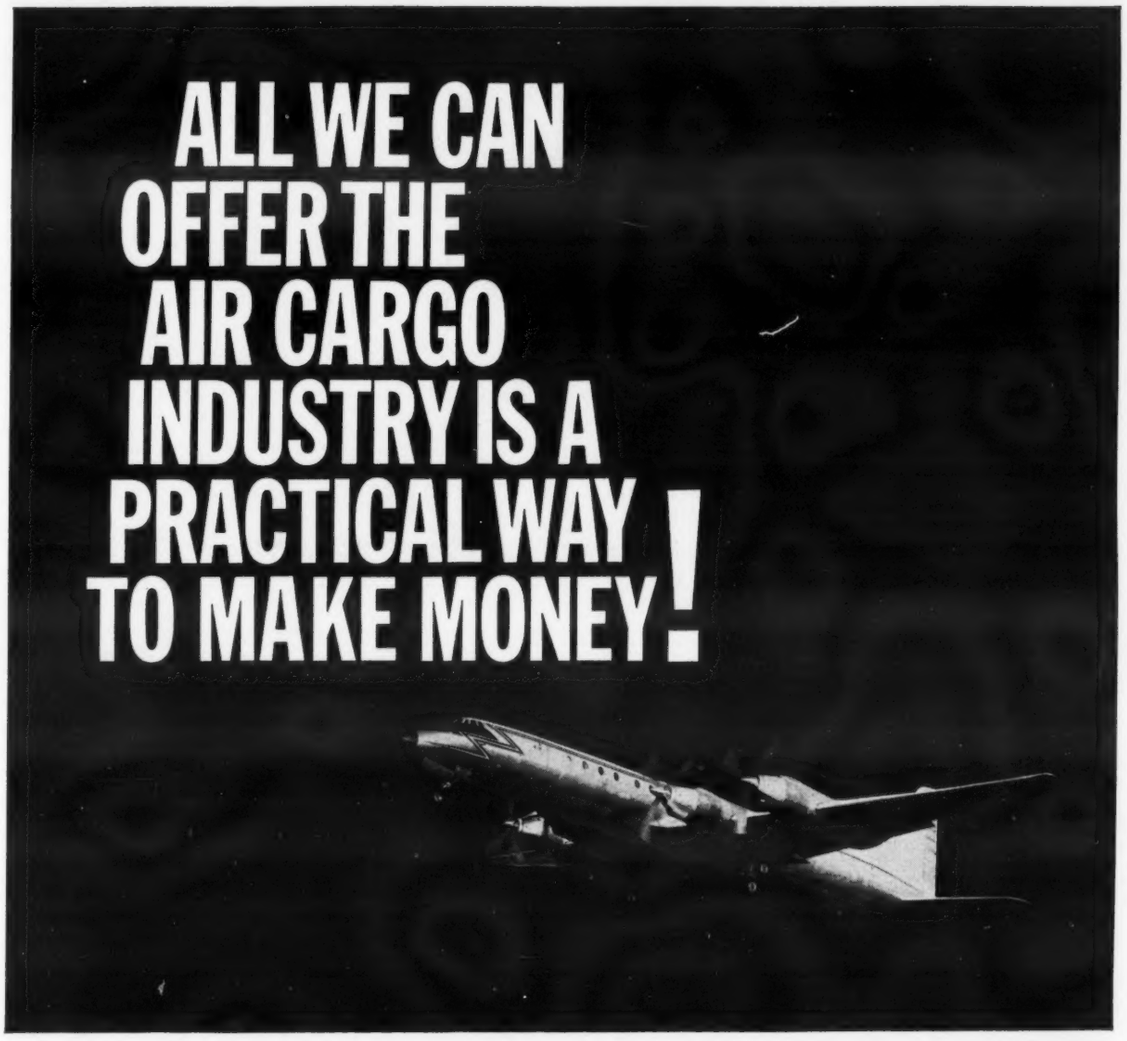

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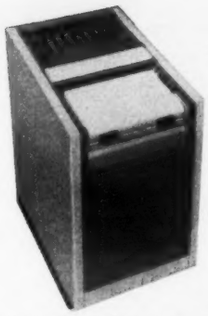

8 CHANNEL RECTILINEAR RECORDER

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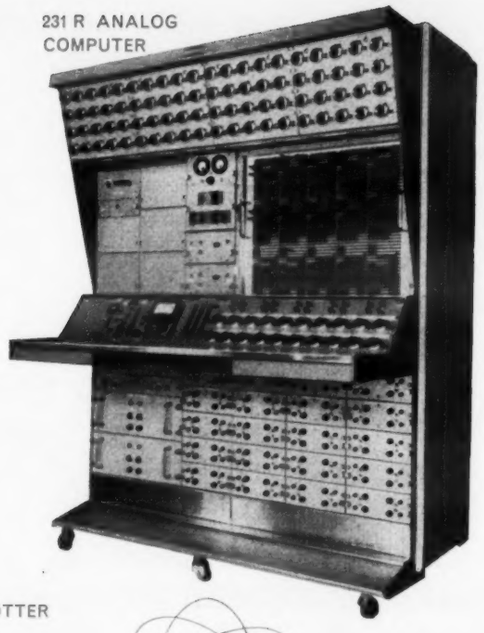

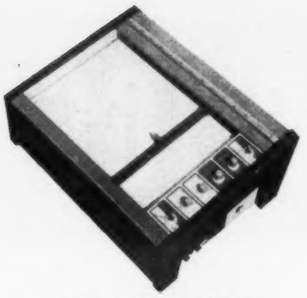

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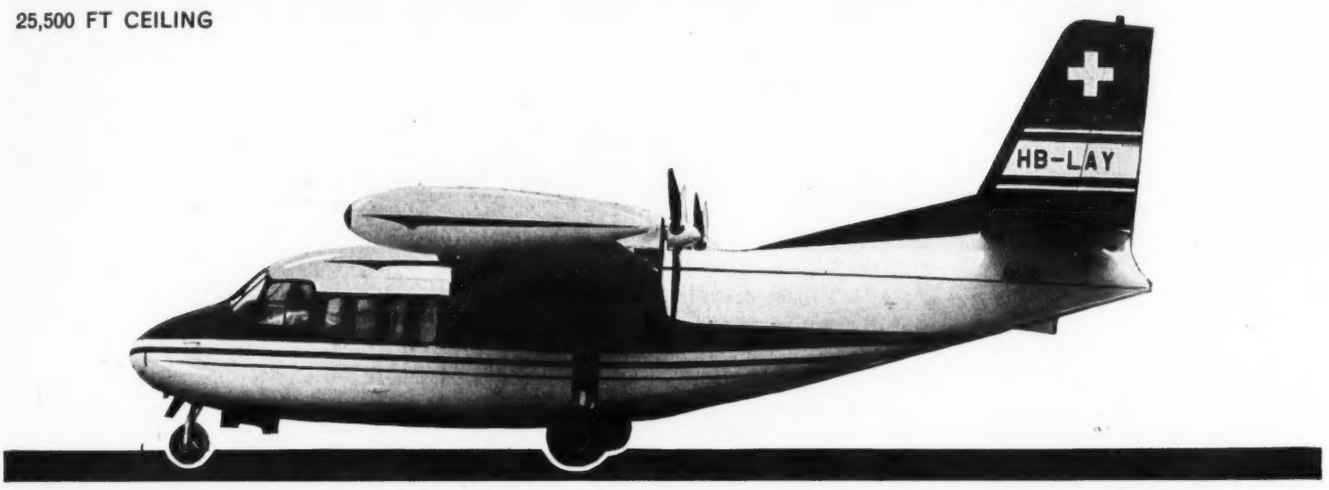

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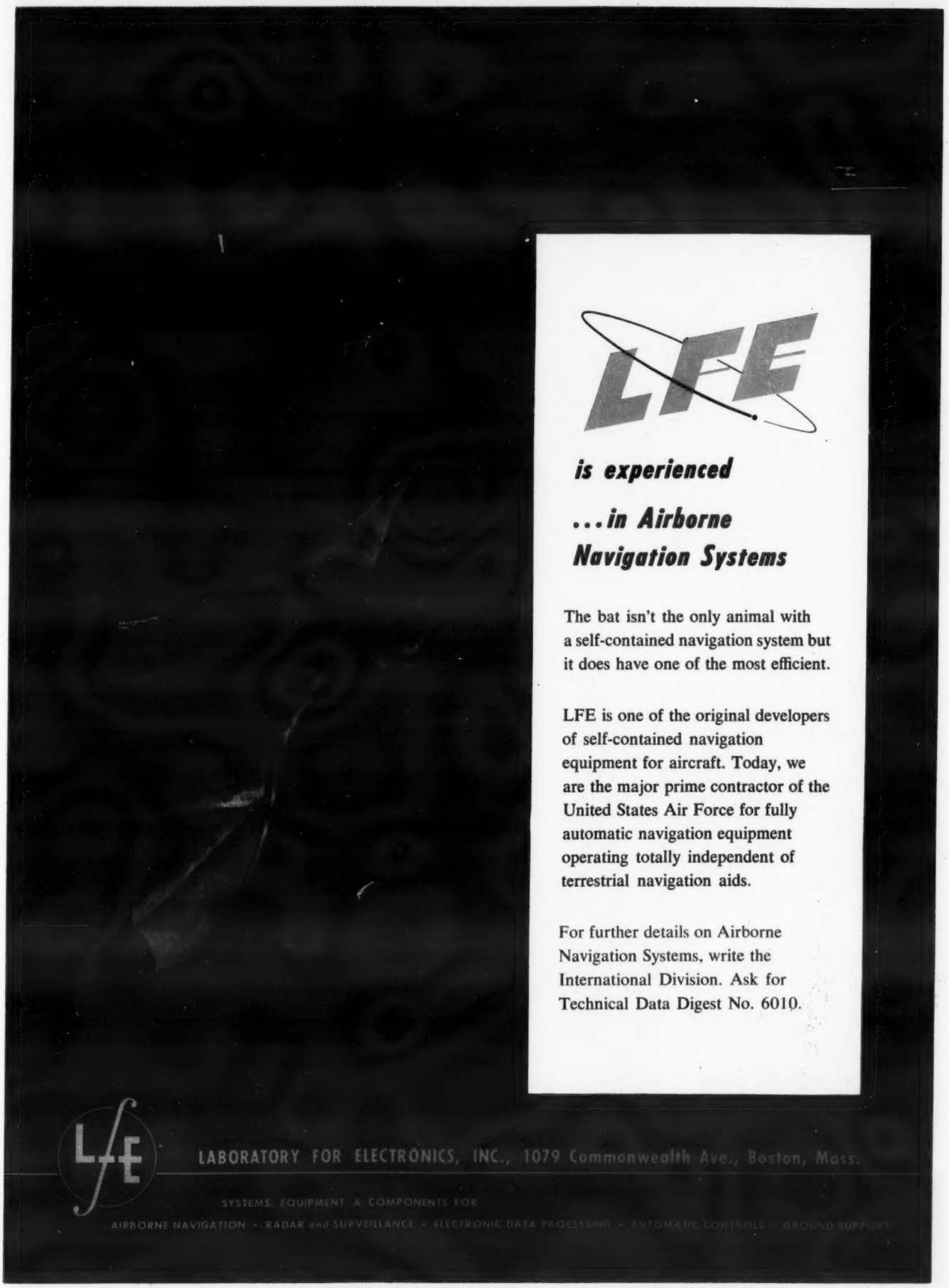
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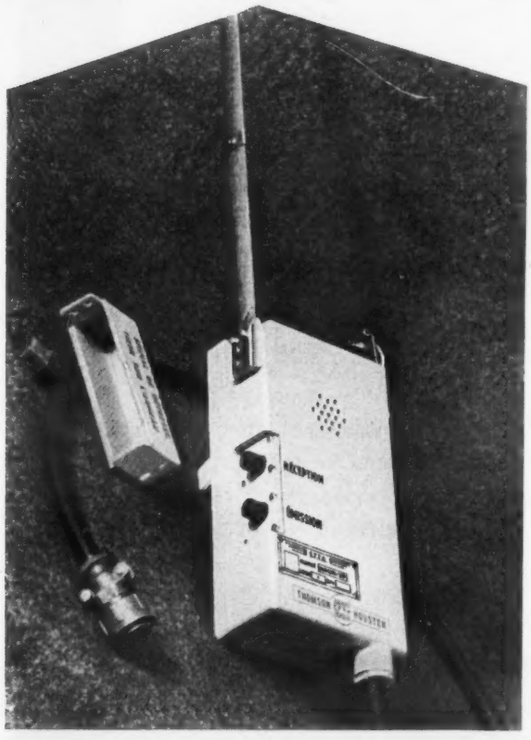

Weighing only 1 lb, the TH.C.986 automatic sub-miniature transmitter-receiver is simple and reliable in operation; it enables a survivor to signal his position to any aircraft with a homing device or a UHF receiver tuned to the distress frequency. Its R/T operation also enables survivors to communicate with aircraft.

Ranges: 30 miles (R/T), 60 to 75 miles (W/T)

The distress signal is automatically transmitted by pulling a ring, and speech communications are made by a unit consisting of microphone and headpiece. The equipment is completely waterproof in up to 13 feet of water. It can be supplied either from a dry battery or from a battery actuated by contact with sea water. TH.C.986 sets are normally preset in the 238-248 Mc/s band and are tuned to the UHF aeronautical distress frequency (243 Mc/s) ; if required, they can be set to the VHF aeronautical distress frequency (121.5 Mc/s).

Low consumption gives high endurance: 15 to 30 hours according to battery used

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The equipment works in the 225-399.9 Mc/s frequency range on 3,500 channels spaced at intervals of 50 kc/s. Any one of these frequencies can be selected without difficulty. COMPAGNIE FRANÇAISE THOMSON-HOUSTON manufactures a similar 1,750-channel equipment operating in the same range.

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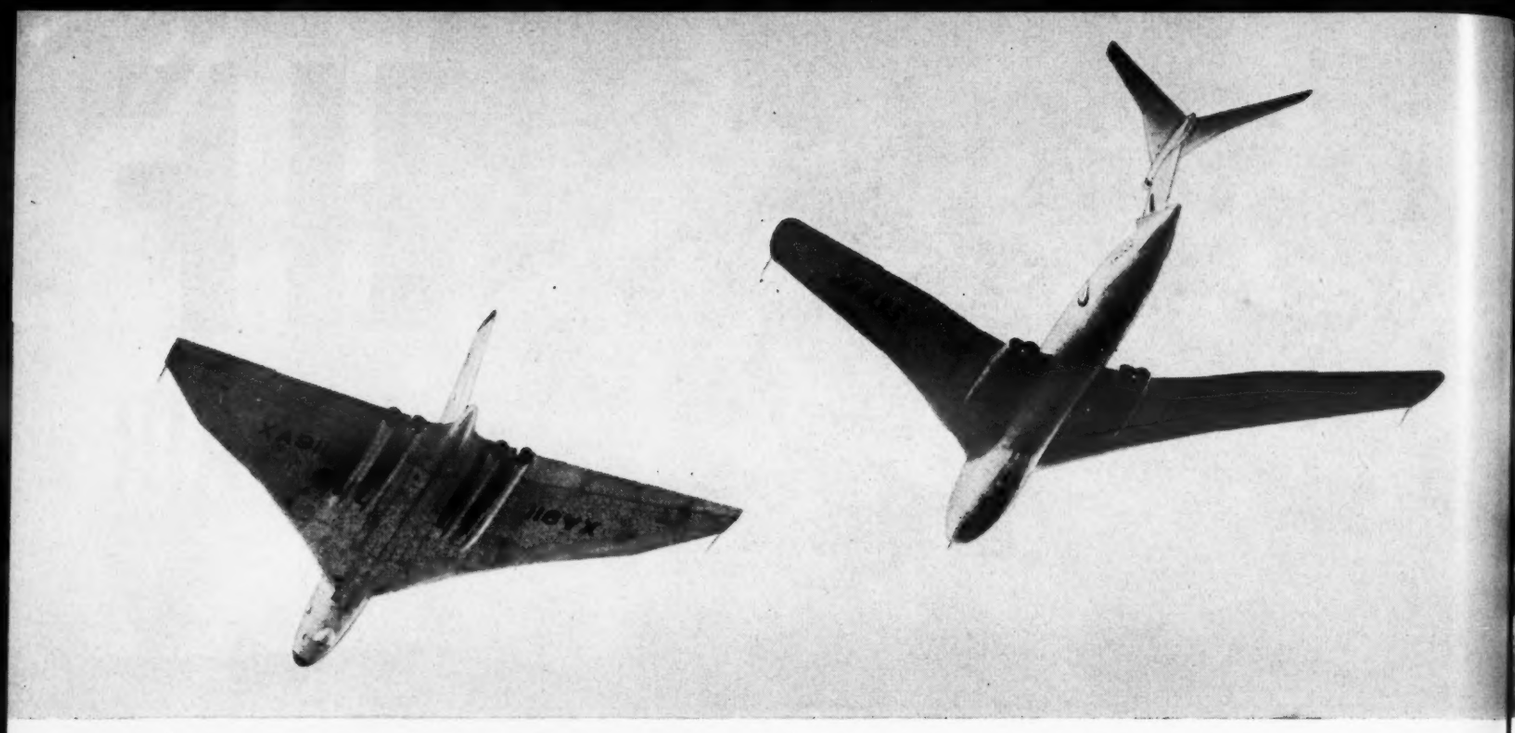
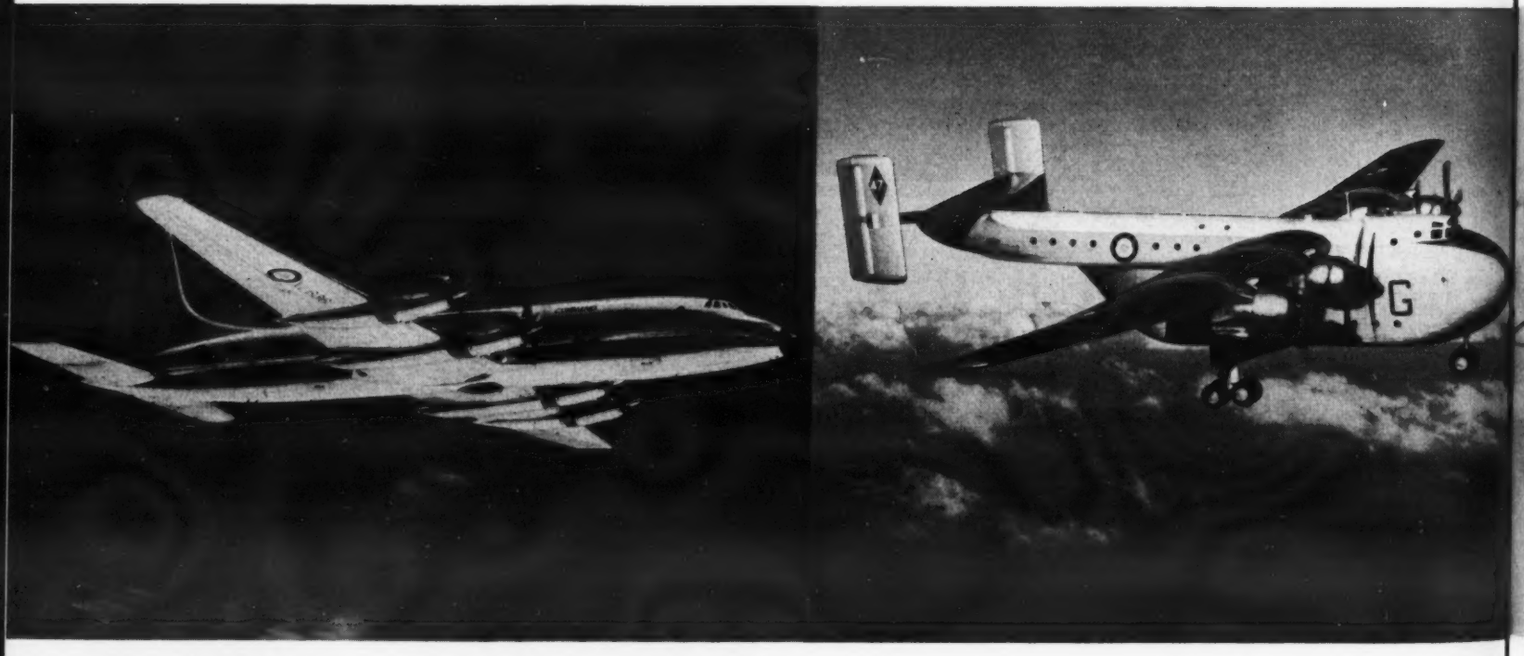


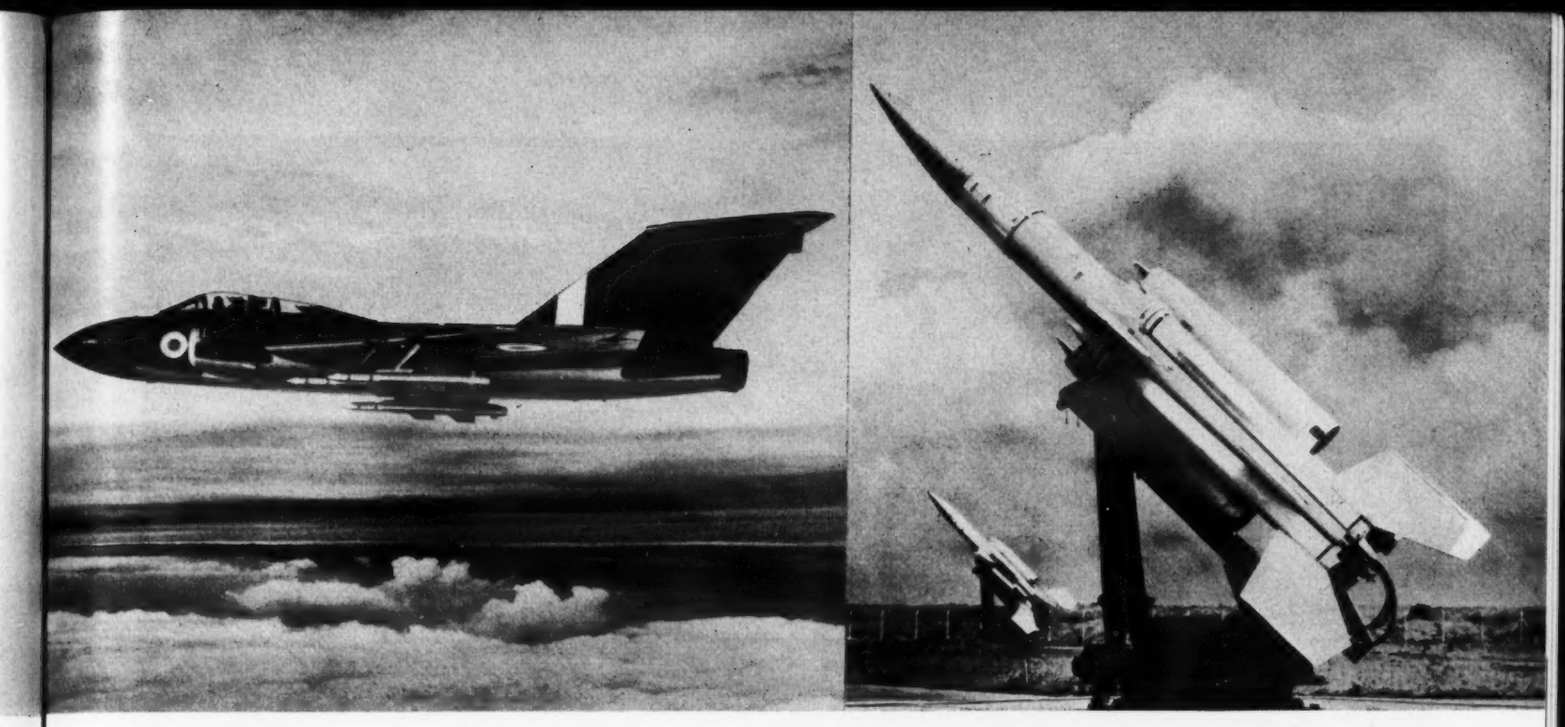
RAF V-bombers fly 10 miles a minute, 10 miles up, for 10 hours . . .



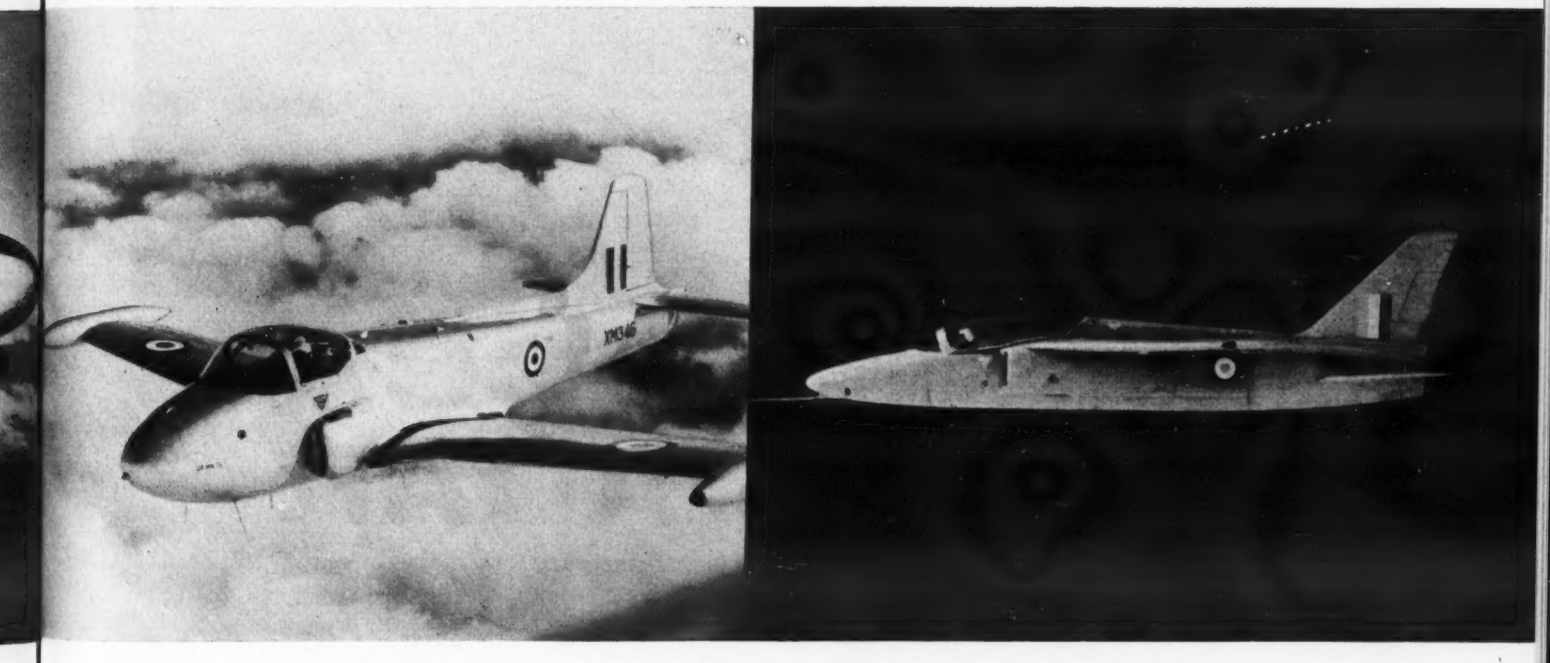
RAF Transport Command provides 5,000-mile range—20-ton payload capacity . . .

. . . AND BRISTOL SIDDELEY

Bristol Siddeley Engines Limited, one of the largest manufacturers of aero-engines in the world, supply flight power for a large proportion of the aircraft and missiles of the Royal Air Force. The most potent part of the RAF's strategic V-bomber fleet, the bulk of its round-the-clock defence, the majority of its transport aircraft and all its new primary and advanced jet trainers are powered by Bristol Siddeley.



RAF round-the-clock defence intercepts aircraft hundreds of miles out, far up into the stratosphere . . .



RAF Training Command orders the latest primary and advanced jet trainers . . .

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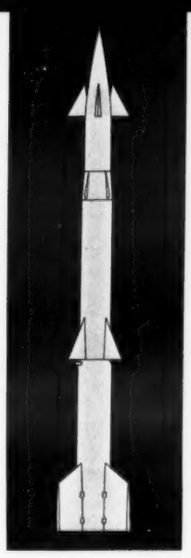


Latest version of the *Nike-Zeus* anti-ICBM.

Nike-Zeus development

At a demonstration on new tactical guided missiles for Project MAN (Modern Army Needs) at Fort Benning, Georgia, the U.S. Army showed for the first time a mockup of a new version of the two-stage solid-propellant *Nike-Zeus* anti-ICBM (see picture), which differs considerably from earlier experimental versions. The 24-ft first stage is slightly shorter, the 41-ft two-part second stage (with nuclear warhead) somewhat longer. All the control surfaces are smaller, and control during the launching phase is now achieved with the aid of the rear surfaces.

Developed by Thiokol Chemical Corporation, the first-stage motor, with a thrust of about 450,000 lb, accelerates the *Nike-Zeus* at more than 20 g. The second stage is powered by a Grand Central Rocket Company motor. This advanced sustainer has very thin walls and a plastic nozzle developed by Douglas. Bell Telephone Laboratories (which is responsible for coordinating the entire system under contract to the Army Rocket and Guided Missile Agency) designed the complex radar monitoring and tracking network and the missile's guidance system. In addition to Bell and its subsidiary Western Electric Company, Douglas Aircraft Company is responsible for airframe, powerplant, auxiliary systems, ground support and test equipment. Among the hundreds of subcontractors are Thiokol, Grand Central, Burns & Roe, Continental Can Company, Goodyear, Lear, North American, RCA, Remington Rand and Sperry.

First tests of the *Nike-Zeus* radar system are due to begin shortly. A 78-ton radar is being installed on the Atlantic island of Ascension, to track missiles launched from Cape Canaveral.

The decision to speed up the *Nike-Zeus* development programme was taken in spring 1957; the first stage was tested in 1958, and the booster made its first static test run in May 1959. Flight testing of the *Nike-Zeus* began at White Sands Missile Range, New Mexico, in December 1959. In April 1960 an experimental rocket was launched from a silo at the range. However, White Sands is too small for further tests, and new facilities are being erected at Point Mugu, California, and on Kwajalein Island in the Pacific.

According to latest reports, the Department of Defense has abandoned its plans for using the *Jupiter* IRBM as a "flying target" in *Nike-Zeus* tests. Following a recommendation by Dr. Herbert F. York, Director of Research and Engineering at the Department of Defense, the U.S. Army will purchase 18 *Atlas* ICBMs (which are more suitable for simulating an "attack") and fire them from Vandenberg AFB at the island of Kwajalein, about 4,800 miles away. Regardless of the target missile selected, the *Nike-Zeus* programme is to be still further speeded up, to enable the weapon to become operational in two years instead of the six years originally planned.

Atlas as booster

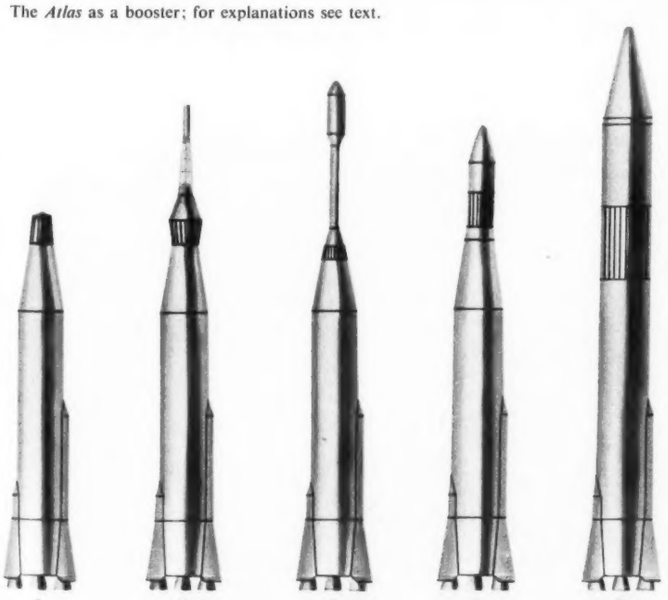
Development of the SM-65 *Atlas* intercontinental ballistic missile (weapons system WS-107A-1) began in 1946 with a USAF research contract to Convair. The research version XM-774 was fired in 1948. In 1955 *Atlas* production began at San Diego; first deliveries were made in the autumn of 1956, and flight testing began on June 11th, 1957. *Atlas B* made its first flight on July 19th, 1958, *Atlas C* on December 23rd, 1958, and *Atlas D* on July 28th, 1959. The U.S. Air Force has also announced that Convair has now developed a model E of the *Atlas*. The powerplant, a Rocketdyne MA-3, is lighter and structurally simpler than that of the earlier models. Power is given as 389,000 lb.

Picture shows the *Atlas* used as a booster: 1. basic version *Atlas D*, 75 ft 10 in. long; 2. *Atlas-Mercury*, 94 ft 6 in. long (an *Atlas D* will put the manned McDonnell capsule into a 120-mile orbit around the earth); 3. *Atlas-Able*, 99 ft 4 in. long, to carry probes to the vicinity of the moon or into interplanetary space; 4. *Atlas-Agena*, 88 ft 2 in. long, to launch the *Midas* and *Samos* reconnaissance satellites (with the *Agena B* as second stage length is 98 ft and launching weight 280,000 lb; to launch earth satellites, moon and space probes from 1961 onwards); 5. *Atlas-Centaur*, 107 ft 8 in. long, for heavy earth satellites and large space probes; first firing is scheduled for 1961.

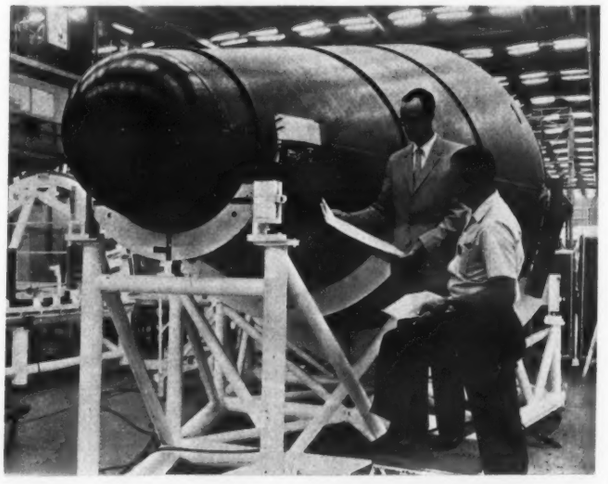
Polaris launched from submerged submarine

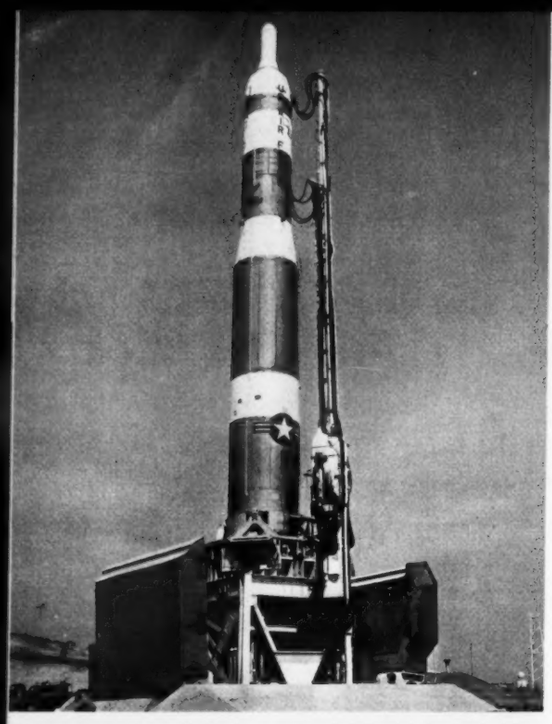
After four years of development work and nearly seventy launchings on land or from a surface vessel, the first launchings of *Polaris* missiles from the submerged submarine "George Washington" were made on July 20th, 1960. At the time the "George Washington" was off the Florida coast some 30 nautical miles from Cape Canaveral, and at a depth of about 90 ft. The first *Polaris* was fired at 01:39 hrs local time and came down in the target area some 1,100 miles distant. Its first-stage engine ignited according to schedule shortly

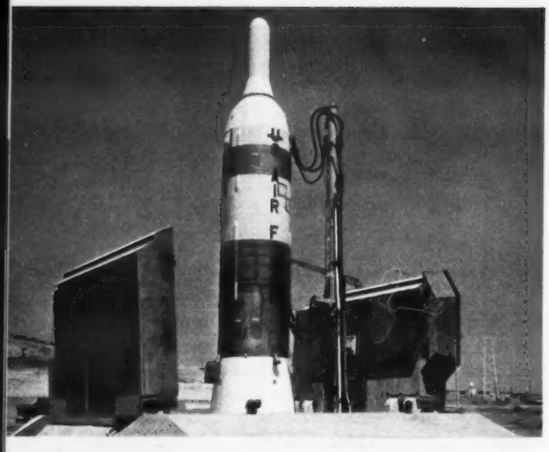
The *Atlas* as a booster; for explanations see text.

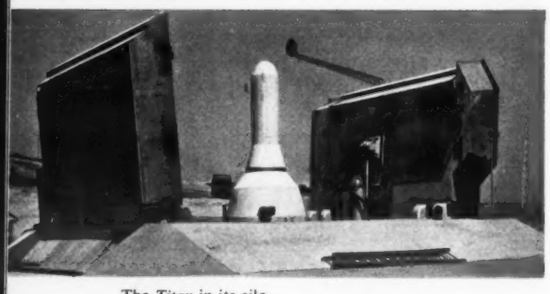


The Convair division of General Dynamics Corporation has built the first *Atlas-Centaur* nose cone at its Fort Worth, Texas, plant. The nose cone consists entirely of heat-resistant plastics (honeycomb sandwiched between two fibreglass layers). With a length of 18 ft, the cone has a diameter of 10 ft at its base. The first nose cone will be tested on the ground by Convair Astronautics at San Diego, California; later ones will go to Cape Canaveral.

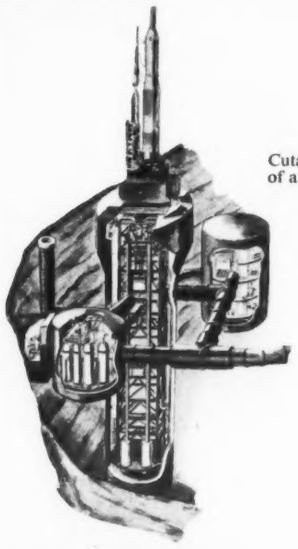








The *Titan* in its silo.



Cutaway drawing of a *Titan* silo.

after leaving the water, the second stage at an altitude of roughly 70 miles. The speed of the "George Washington" was about two knots. At 04 : 22 hrs local time a second *Polaris* was also successfully fired. Neither of the two missiles was fitted with a warhead, and the Navy stresses that several weeks of tests will be necessary before the *Polaris* can be declared operational.

Hardened Titan sites

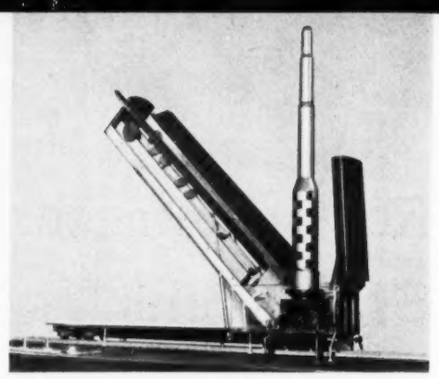
The Air Force Ballistic Missile Division will fire its first Martin SM-68 *Titan* ICBM before the end of the year, from the U.S. West Coast and from a hardened underground site at Vandenberg AFB, California. Known as the Operational Systems Test Facility, the Vandenberg installation, pictured here, is the forerunner of all *Titan* underground silos. During the last few minutes before launching, the doors open, the rocket is raised to the earth's surface, and the order to launch is given.

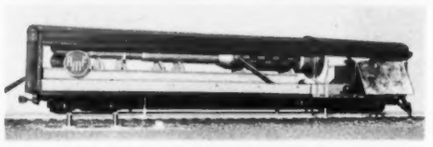
The *Titan* illustrated is not to serve for launching, but merely to test the large number of installations belonging to the *Titan* weapons system. As will be seen from the drawing, two bunkers are required—in addition to the silo—for fuelling and test equipment.

Hardened underground silos are under construction at the following air force bases: Lowry AFB, Denver, Colorado (two squadrons with nine *Titans* each, operational by mid-1961); Mountain Home AFB, Idaho (one squadron); Larson AFB, Moses Lake, Washington (one squadron); Ellsworth AFB, Rapid City, South Dakota (one squadron). *Titans* in later squadrons will be launched directly from the silos. squadrons equipped with the advanced version, the *Titan II* (cf. *Interavia* No. 7, 1960, p. 771), will be stationed at the following sites: Davis-Monthan AFB, Tucson, Arizona (two squadrons with nine missiles each) and McConnell AFB, Wichita, Kansas (two squadrons). A further four *Titan II* squadrons are to be stationed at bases as yet unspecified.

The technical management and coordination of the Air Force Ballistic Missile Division's *Titan* project is in the hands of Space Technology Laboratories. The main contractors are The Martin Company (airframe, fabrication and testing), Avco Manufacturing Corporation (re-entry vehicle), Aerojet-General Corporation (first-stage powerplant: two XLR-87-AJ-1s of 150,000 lb thrust each; second-stage powerplant: one XLR-91-AJ-1 of 80,000 lb thrust; propellant RP-1 and liquid oxygen), Bell Telephone Laboratories and Remington Rand Univac (radio guidance), A.C. Spark Plug (inertial guidance, based on an MIT development), AMF (silo and launcher), and A.D. Little (propellant loading system).

The *Titan* made its first flight on February 6th, 1959, though at that time only one stage was ignited. On May 4th, 1959 the second stage was ignited for the first time; and on February 2nd, 1960 the missile made its first two-stage flight with both stages firing. The first long-distance flight with separation of the nose cone and recovery of the instrument capsule was made on February 24th, 1960. A detailed report on the development of *Titan* was published in *Interavia* No. 7, 1960. ←





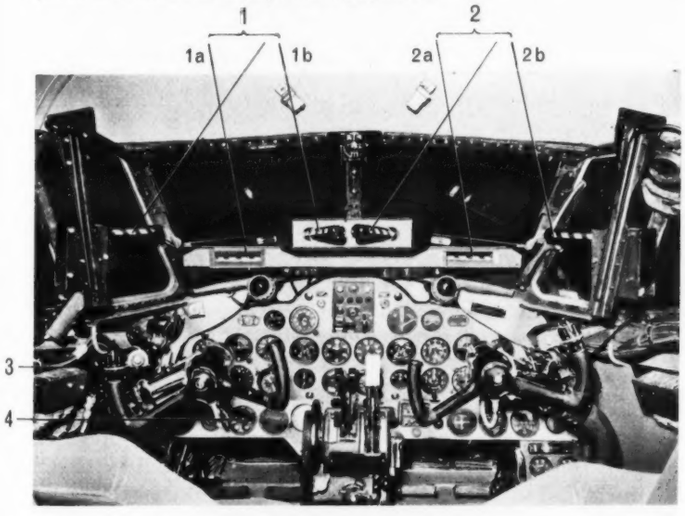
Model of a railway launching platform for the *Minuteman* ICBM. The railway waggons proposed by the American Machine & Foundry Company can also be used for transporting the missile (lower picture). Before the launching, the waggons are anchored by stabilizing outriggers. The missile erector, of light metal construction, then rises to a vertical position and drops back when the *Minuteman* is fixed to the launch ring (upper picture). The missile is guided from a separate control car. Present plans are for fifty *Minuteman* railway launching platforms.

Titan production at the Denver Division of the Martin Company. The first and second stages can be seen in various stages of assembly. In the rear, right, is a complete first stage. The finished missiles are flown to Cape Canaveral in Douglas C-133A *Cargomasters*.

What's New in Electronics?

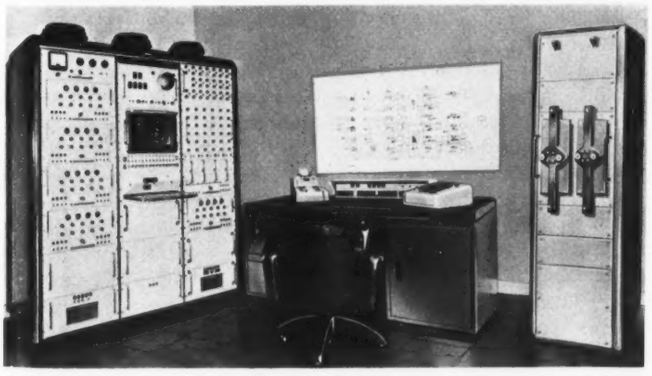
● **Smiths Aircraft Instruments (Research and Engineering Dept.), Cheltenham, England,** recently gave a series of demonstrations of the Smiths *Para-Visual Director* (P.V.D.) in the company's *Dove* aircraft. This instrumentation is the outcome of investigations into methods of conveying visual information to a pilot without it being necessary for him to look directly at an instrument display. Three units are mounted in the cockpit, the one ahead of the pilot giving azimuth information, while the two at either side, which are slaved together, give pitch information. An incorrect attitude of the aircraft causes the displays to move in such a manner that the patterns appear to be moving from side to side on the bank unit and forwards or backwards on the pitch unit. The aircraft controls are moved in the same sense as the apparent movement of the displays until display movement ceases; the aircraft is then on the desired flight path. The dynamic nature of the display is such that the pilot can absorb the information from the "corner of the eye," leaving his vision free to carry out other tasks.

With connection to the ILS mode of the *Smiths Flight System* it has been proved possible for a pilot to maintain accurate instrument flight during the approach path and at the time concentrate his fixated vision outside the cockpit preparatory to picking up visual contact with the runway ahead for the actual landing. The simplicity of the system was adequately demonstrated by the fact that a member of the *Interavia* staff with no previous piloting experience was capable of maintaining accurate instrument flight for a period of over fifteen minutes during the demonstration in the *Dove* aircraft.

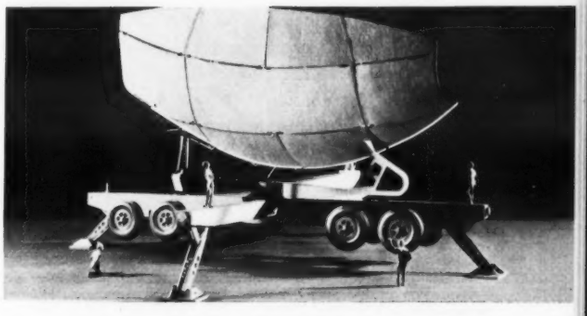


1 Captain's P.V.D.
1a Azimuth display
1b Pitch displays
2 Co-pilot's P.V.D.
2a Azimuth display
2b Pitch displays
3 P.V.D. Pitch datum unit
4 P.V.D. Controller

● **Redifon Ltd., Crawley, England,** has introduced a new analogue-digital computing system, called RADIC. The equipment has been designed for use as a system rather than a fixed-size computer, and can be expanded to meet the requirements of the user. It has been specifically developed to integrate the stability, convenient input/output equipment and storage facilities of the digital machine with the speed, ease of programming and low cost of the analogue. A major field of application will be the analysis and computation necessary for designing process control equipments used in the oil, steel, aircraft, chemical and nuclear industries.



● **The General Electric Company, New York, N.Y.,** is working in conjunction with the McKiernan-Terry Corporation on a new concept in mobile long-range radar. Termed "Project Butterfly" because of its high mobility and retractable folding antenna structure, the design provides full manoeuvrability not previously available with equipment of this type. A second trailer unit houses the radar display and power generating equipment and furnishes its own lighting, heating and air-conditioning for all-weather operation. The two trailers can be air transported in a single C-124 aircraft. The 20×43 foot folding antenna can be erected by a five-man crew in fifteen minutes, and in the retracted position will withstand winds in excess of 100 m.p.h.



● **Librascope Division, General Precision Inc., Glendale, Calif.,** has developed a "universal" circuit card which can be prefabricated and adapted to different computer circuit requirements. The card carries a standard etched pattern which can be modified by interconnections to fulfil any desired circuit function. Librascope engineers emphasize that this technique does not result in the most compact packaging, nor in a card that is particularly adaptable to mass production. On the other hand it offers significant savings in production time if a single computer or less than five units are being built. Another feature of the card is that a duplicate connector is provided on the top of each unit. This permits the card to be connected to a test instrument and checked while it is plugged into the computer, thus materially reducing testing time during final inspection.

The Case for the Flight Data Recorder

By Albatross, London

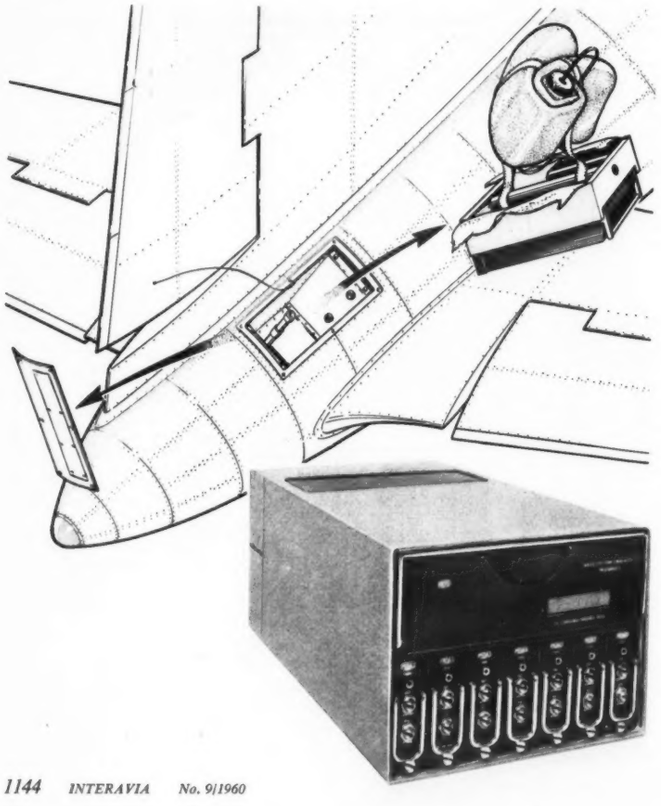
A Handley-Page *Victor* bomber took off from Boscombe Down about a year ago and vanished without trace. The five men aboard were killed.

There is no way of assessing the cost of human life, but in terms of hardware the loss has been estimated at £2,500,000. Since the mishap, more than £250,000 have been spent trying to find the wreckage and to discover what went wrong. Every now and then a trawler recovers some fragments of torn metal, but so far the investigators appear to be none the wiser.

Had the *Victor* been fitted with a crash recorder of the type that ejects automatically from a stricken aircraft, carries flotation gear and a SARAH search and rescue transmitter, the chances are that a complete analysis of the accident would now be available, and the vast cost of the search saved.

A crash recorder of this kind has been developed in Britain, but in designing it, the Royston Instrument Company of Byfleet, Surrey, have broadened its uses beyond those required for determining the causes of a crash. Recording up to 300 parameters at a time, the basic function of the MIDAS system (cf. *Interavia*, January 1960) is to provide a complete and permanent record of every important parameter throughout the life of an aircraft, so that repair and maintenance can be carried out without loss of time in diagnosing faults, damage or fatigue.

The MIDAS CMM 400/7A flight recorder and diagram of ejection. The folded flotation body is automatically inflated, and the antenna for the emergency transmitter springs into position.



With such capabilities, the exciting thing about this kind of data recording equipment is that it has the potential to make an enormous impression on airline economics and revolutionize inspection, repair and overhaul techniques and standards.

Under the present system of servicing, a reported snag will lead an engineer through a systematic check and finally to the source of the trouble. His investigations may stretch into a two-hour delay and the usual run of consequences: interrupted schedules; extended crew duty or upset rostering; passenger irritability and general inconvenience, all of which add up to increased costs. Besides, there is the possible loss of passenger goodwill and confidence which cannot be economically assessed. Flight data recorders have the potential to eliminate all these.

The repair and overhaul implications run far deeper. Oversimplifying the case, they are scheduled today on flying hours to which a large margin is added for safety. It is the only standard aviation has been able to apply in the absence of a better one, but when closely analyzed, it is unrealistic, even though the adoption of component sampling considerably improves the situation. It is unrealistic because every aircraft experiences individual take-off, landing and in-flight strains which markedly influence the true life of the components in its structure.

By employing flight recorders, all vital components can be *watched* and progressively sampled so that the life of an engine, for example, might rise from 1,200 hours to 4,000 hours, thus influencing economy by a considerable margin, or fall to 800 hours, in which case safety would be immeasurably increased.

The Air Registration Board is reported to be prepared to alter the basis for assessment on aircraft and engine life, provided an airline uses flight data recorders on every aircraft on a given fleet from the time they go into service.

Now you would think the Air Force and the airlines of the country in which this system was developed would seize the opportunity of at least sampling this equipment! Not a bit of it. They are dragging their feet; and from the evidence it would appear that the advisory "nigger in the woodpile" is the Royal Aircraft Establishment at Farnborough, which always seems to raise objections to anything for which it did not write the specifications. The current joke circulating Britain's aeronautical fraternity is that Farnborough's specification for a horse is a camel. The result is that the Lockheed Aircraft Corporation has acquired the American rights for the system, in which Delta Airlines and TCA have shown a profound interest.

Be that as it may, the fact remains that equipment of this kind has the potential to do away once and for all with the uncertainties that plague aviation.

Take the case of the BEA *Elizabethan* crash at Munich two years ago. Was ice on the wings, slush on the runway or loss of engine power responsible? Agreement on the cause appears to be difficult to reach—a situation made all the more difficult by the fact that a lot of water has passed beneath the bridge since the accident, with the result that the memories of the witnesses have lost their crystal clarity.

The argument is academic, but had a crash recorder been fitted to the aircraft at the time, any doubts about the integrity of the engines would have been eliminated long ago, since propeller r.p.m. and torque pressures would have been recorded. And since airspeed would also have been taped, the question of whether the aircraft actually reached unstick speed would have had an indelible answer.

The next disaster to claim attention is the BEA *Viscount* which crashed at Manchester. There, by a clever piece of detection, the investigators discovered that an aileron had jammed after a bolt had sheared in the flap assembly. To analyze the cause would have demanded the recording of aileron and flap angles at the time of the accident. Obviously, rudder and elevator angles would also have been required.

We move on now to a more mysterious crash. The BEA *Viscount* which suddenly plunged into the ground out of a thick overcast at Nutts Corner, Belfast, several years ago. No reason for this accident was ever discovered, although several theories were advanced: the discovery of a bent screwdriver near the control lines gave reason to suppose that the controls had jammed. On the other hand, the malfunctioning of some of the aircraft's automatic equipment has been suspected. Aileron, flap, rudder and elevator angles together with a record of the automatic equipment's behaviour would have been valuable.

No one really knows to this day precisely what went wrong with the *Britannia* which crashed at Filton a year or more ago. Control surface angles and automatic equipment behaviour records would undoubtedly have solved the mystery which cost 14 lives.

Finally we have the *Comet* accidents of 1954. It took many months of brilliant, painstaking work to discover what sent these sleek, futuristic airliners plunging to their doom. Fitted with a recording system it is quite possible that the weaknesses inherent in these aircraft would have been detected long before metal fatigue in the cabin took its toll.

I am not trying to be wise after these events, as no doubt some people would try pointing out. The compact recorders available today were not available at the time these disasters occurred. What I am pointing out is how valuable the evidence obtained would have been to aviation in general had recorders been fitted to these aeroplanes, and that aviation cannot afford to ignore the technical developments capable of improving safety.

Although a system capable of recording up to 300 parameters simultaneously is available today, the requirements still recommended by certain authorities in their specifications for a crash recorder number only the following six parameters:

a. Airspeed indication
b. Altitude
c. G.
d. Time
e. Lateral acceleration
f. Longitudinal acceleration

Now, what sort of mumbo-jumbo is this in an era which prides itself in being called the *Jet Age?* These parameters are equivalent, more or less, to the questions investigators have been asking eye-witnesses for years. Eye-witnesses have always been regarded with a certain apprehension. Does this mean the imagination of the authorities can stretch no more than to carry the eye-witness formula into regions beyond which the eye cannot see?

The FAA, in all fairness, does appear to have realized that something a little more sophisticated is necessary to help in accident investigation, and proof of this appeared in the Wall Street Journal of January 21st, 1960.

"In the area of post-crash detection," said the Journal, "the FAA is studying, and probably leaning toward, a requirement that would put Flight Data Recorders on most airline planes.

"At present, recorders are only required on jet-powered craft certified to fly above 25,000 feet.[1] This covers two of today's planes, the Boeing 707 and the Douglas DC-8, the newest pure jets operating in the United States air fleet.

"The recorders report time, direction, speed, altitude and the plane's reaction to vertical gusts. FAA Safety Officials believe these could be improved to report almost any data—wing or propeller malfunctions, fuel flow and even explosions.

"The recorder must now withstand fire and the impact of a crash. One FAA official feels that they should float and could even be devised to release and surface from a plane downed in water, although finding them would be more difficult even than locating data capsules in rockets or missiles launched over water."

The question is: How few parameters would it have been necessary to record to discover quickly and accurately the causes of the accidents quoted earlier? The answer is twenty-three—twenty-five if lat' and long' were to be considered necessary!

According to many people this number is too high. What they fail to appreciate, however, is that it is as important to know what went *right* as what went *wrong*.

The cost of equipping a fleet of aircraft with flight data recorders is frequently advanced as an objection to their acquisition. And yet, when you consider that the £250,000 it cost to try locating the crashed *Victor* bomber would have covered the equipment for 80 aircraft of the same type, the argument no longer makes sense.

Aeronautics has evolved faster than any other form of transport and is constantly meeting with new problems which also evolve in complexity. There are fine sentiments to keeping time-honoured methods of solving these problems, but whoever does can expect one day to be awakened with a rude shock. ◆◆

Parameters which would have been essential to determine the cause of the following crashes.

❶ *Viscount*—Manchester.
❷ *Elizabethan*—Munich.
❸ *Viscount*—Belfast.
❹ *Britannia*—Filton.
❺ *Comets*—Elba and Naples.

Suggested absolute minimum parameters	❶	❷	❸	❹	❺
1. Airspeed	×	×	×	×	×
2. Altitude	×		×	×	×
3. "G"	×		×	×	×
4. Time	×		×	×	×
5. Lateral acceleration	×		×	×	×
6. Longitudinal acceleration	×		×	×	×
7. Directional acceleration	×		×	×	×
8. Port aileron angle	×		×	×	
9. Starboard aileron angle	×		×	×	
10. Port elevator angle			×	×	
11. Starboard elevator angle			×	×	
12. Tailplane angle					
13.—21. Propeller RPM, torque pressure, or EGT, and thrust (4 engines) = 8 parameters		×			
22. Autopilot aileron servo			×	×	
23. Autopilot elevator servo			×	×	
24. Autopilot rudder servo			×	×	
25. Cabin pressure					×
26. Flap angle—port	×			×	
27. Flap angle—starboard	×			×	
28.—31. Undercarriage locks					
32.—33. Dive brakes					
34.—37. Fuel quantity					
38. Outside air temperature to assist in determination of Mach No.					×
39. Heading					
40. Longitude / 41. Latitude — From Doppler* or Air Log					
42. / 43. Artificial Horizon			×	×	

* A position recording would have quickly determined whether the *Viscount* collision in Italy was in or out of Control Zone.

[1] The FAA has since ordered that all jet and turboprop airliners must be equipped with flight recorders by November 1st, 1960. *Ed.*

Avionics – A Technician Looks at the Present and Future

By Charles B. Bovill, Decca Radar Ltd., London

The introduction of jet aircraft into airline operations has clearly revealed the shortcomings of today's traffic control systems. The ensuing heated discussions on the best way to improve present methods give a special note of topicality to the following article by an expert who has been active in the aeronautical electronics business for 25 years. Editors.

A decade and a half have passed since the recommencement of civil aviation operations, and in this period very important advances have been made in aircraft and their modes of operation. It is therefore timely to examine progress in the associated field of avionics and to endeavour to forecast its future trends.

Throughout the period in question, as operational requirements have emerged, compromise has followed compromise, black boxes have been added to the installation, various antennae have been fitted to aircraft, but little genuine systems engineering has found its way into avionic installations.

Such a state of affairs cannot continue if electronics are to serve aviation in the efficient way of which they are capable. This being so, it would seem timely for aircraft manufacturers and airline operators to take a new attitude towards avionic equipment and give consideration to some new philosophies.

When radio equipment was first used in aircraft, its designer was forced to build apparatus of the minimum size and weight because the payload of the aircraft was so small. This tradition has been firmly retained, and various stages of weight and size reduction have been passed through, from small equipment to miniaturization, and now to subminiaturization—in spite of the greatly increased size of the aircraft.

Furthermore, although some efforts have been made to consider the avionic equipment as a whole at the mock-up stage of the design, little has been done to apply the principles of systems engineering at the drawing board phase.

One is forced to consider if this insistence on subminiaturization and its equipment complication and expense is not outdated, in view of the greater reliability, better performance and reduced cost which a small weight concession to the avionic engineer could offer.

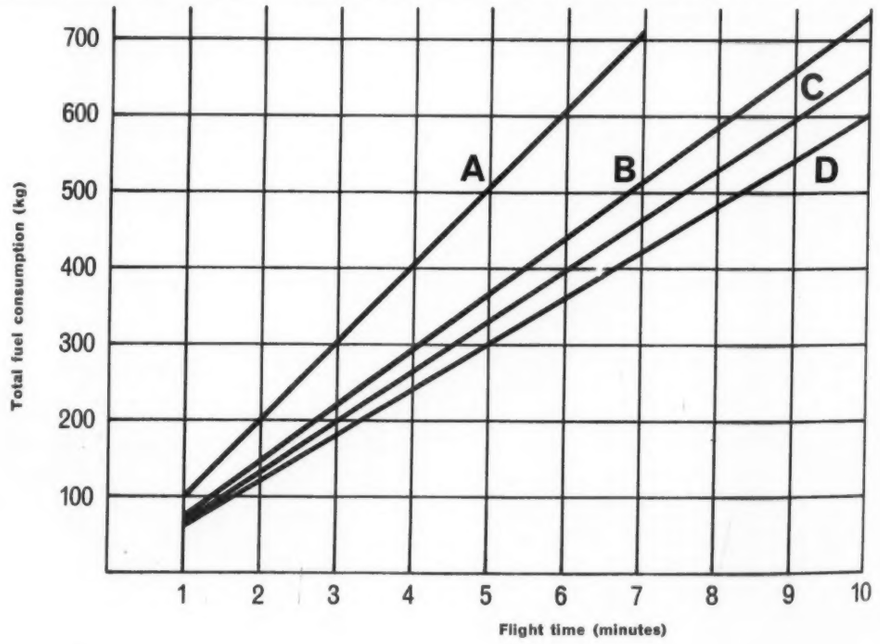
Although it is generally considered to be a delicate matter to touch upon, the fact that a gallon of jet aircraft fuel weighs nearly 8 lb and that it will only propel a big jet for about 5 seconds, is a point worth considering. Five minutes of cruising altitude fuel sacrificed for a 100 percent reliable, cheaper and more comprehensive avionic equipment—say 600 to 1,000 lb extra weight—could enable equipment to be produced which would give the unfailing and accurate navigation needed in the climb, climb cruise, level flight and descent of a jet operation. In addition, it would do much to aid Air Traffic Control. The curves in *Fig. 1* show the weight of fuel consumed on typical jets over a 10-minute period under two normal conditions of flight.

Here it should be mentioned that if the aircraft manufacturer, who knows under what conditions his aircraft is designed to operate, would produce a comprehensive specification of the broad requirements of the avionic equipment, and would provide adequate space for this equipment at the drawing board stage, the electronic engineer could produce an avionic unit which fulfilled the requirements in a far more reliable and efficient way than has been done hitherto. Such a unit could incorporate many new techniques derived from other electronic fields and new ideas which have not yet been used in aeronautical electronics. As an instance, the airborne radar complement in a modern civilian aircraft consists of a cloud warning radar, DME, radar altimeter, transponder and Doppler. At present, each of these equipments is an entity in itself with its own antenna, transmitter, receiver, power supply and display. Much of the circuitry is very similar; for example, each equipment has its I.F. amplifier, time base, etc. If the service required of these devices is considered realistically, it will be understood that it is not necessary for them all to be indicating continuously—that is to say, it would be sufficient to provide the service for each device every few seconds.

Thus the possibility of a single avionic unit—in place of a number of boxes—can be envisaged, with them all working from one or two transmitters and receivers instead of four, on a time sharing basis, with a sequential service of, for instance, Doppler, DME, Altitude, Cloud Warning and Interrogator, each feeding into a display. Technically this is quite possible to achieve and would seem to be the logical way of fulfilling the requirement; it would simplify the antenna installation, cabling and service. An examination in detail also indicates that two such equipments carried in an aircraft would probably be of smaller cubic size and less weight than equipment of similar performance using the numerous black boxes as at present.

The avionic unit outlined is, it must be appreciated, a step towards further simplification and not complexity. This must be the tendency in the future if the electronic complement of an aircraft

Fig. 1: Fuel consumption for four-jet airliners during cruise. **A**. Boeing 707-420, typical North Atlantic crossing at constant true airspeed (TAS), aircraft weight 125,000 kg; **B**. Boeing 707-420, cruise condition for maximum range, aircraft weight 90,000 kg, altitude 32,000 ft, Mach 0.78; **C**. D.H. *Comet 4C*, level flight, aircraft weight 58,000 kg, altitude 32,000 ft, Mach 0.76; **D**. D.H. *Comet 4C*, climbing cruise, aircraft weight 57,000 kg, altitude 35,800 ft, Mach 0.76.



is to remain an economic proposition to airline operators.

There are also signs of possible simplification in other fields of aeronautical electronics, such as in communications. An experimental station at Shannon, which has been using VHF scatter techniques over the past two years, has given most promising results, and development of this method might enable HF transmitting and receiving equipment and antennae to be eliminated from aircraft. The ultimate result would be more reliable communications, since VHF is not subject to the ionospheric disturbances and static so well known on the HF bands.

*

In considering future trends in avionics, the controversial subject of short and long distance navigational systems must be examined. There is probably no field in aeronautical electronics which has been given so much study by inventors, and at least 20 new systems have been proposed in the past two decades. Most of these, however, have been discarded because they are unsuitable for civilian operations or because, though elegant technically, they are impractical under the arduous conditions of flight.

So far no ideal method has been discovered. Radio waves, by their very nature, appear theoretically to be highly suitable for providing navigational information, but in practice severe difficulties are encountered. The longer waves which follow the curvature of the earth seemed to have all the characteristics of a perfect navigation system, but intensive research and millions of observations have shown that their useful limit of range for highly accurate navigation is somewhere in the neighbourhood of 300 to 400 miles. Beyond this range random reflections, which vary with season and time of day, disturb the action of loop antennae, goniometers and phase comparison grids or lattices. At the other end of the spectrum, at VHF, variations in phase and polarization introduce errors which degrade the accuracy of fixing information. The effective range of VHF navigational systems is limited at present to quasi-optical distances. This means that, at the high speeds of jet aircraft, the service provided by a VHF system, especially under en route conditions, is very short, and that to provide continuous information a great amount of infrastructure in the form of beacons is required.

Out of the many schemes proposed for navigation the only two which have stood the test of intensive civilian operations as short distance systems are the ICAO standard, VOR/DMET on VHF and UHF, and the Decca Navigator operating on long waves. VOR stations provide some 300 million square miles of cover, and Decca about 100 million square miles in the world today. Both systems are expanding and are being improved technically and operationally. The weakness of the VOR system lies in the fact that its accuracy in azimuth is about 5 degrees; this is capable of amelioration by modifications throughout the system from the beacon to the airborne receiver. The ambiguities of the Decca system are largely overcome by the Mk.10 receiving system, which gives automatic lane and zone identification, and research has reduced static interference to negligible proportions. Recently a hyperbolic coordinate converter has been announced which will remove the map distortions from the pictorial display used with the Decca system.

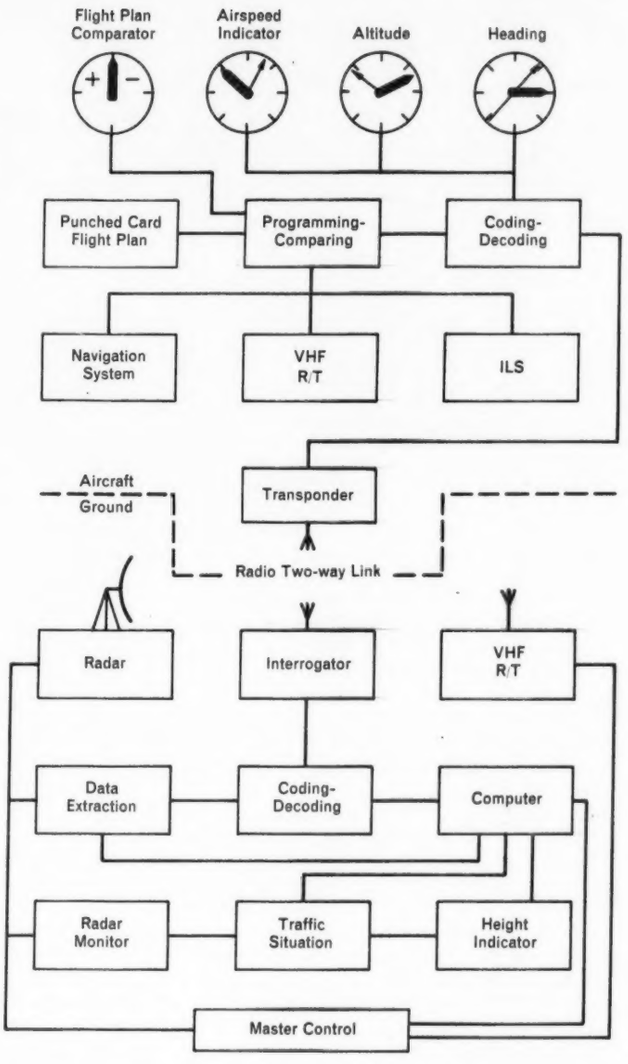


Fig. 2: Block diagram of a fully automatic data link ATC system. The data on the punched card flight plan are fed into an electronic computer, which automatically programmes the complete navigation process, makes the necessary adjustments to the navigation equipment, selects the appropriate VHF frequencies and also switches on the ILS during the final stages of the flight. The output from the navigational instrument is fed to a comparator unit and is compared throughout the flight with the flight plan; a flight plan comparator instrument indicates to the pilot whether the plan is being adhered to in time, position, altitude, etc. The navigational information, plus speed, altitude and heading, are fed to a decoding instrument and thence to the transponder, finally being transmitted to ATC by radio link.

On the ground, the signals sent out by the transponder are received and decoded, and passed to a computer and to a pictorial traffic situation indicator. There is also a height indicator, which derives its information via the radio link from the aircraft's altimeter. The air traffic situation is also monitored by the radar (on the left of the diagram) and is shown on a PPI indicator. Instructions to the aircraft are passed automatically, after computation of the situation, via the data link. In the diagram, the method of passing instructions is by concentric pointers on the basic aircraft instruments, so that a change of heading, altitude or speed can be signalled directly to the aircraft. These concentric pointers can also be used with the flight plan comparator. Thus the pilot, by pressing a button, can compare his speed, altitude and heading readings with what they should be if the flight plan is adhered to.

In comparison with any other short range system, VOR and Decca are so far advanced technically and operationally and so extensively implanted throughout the world, that their replacement by any other system seems unlikely.

*

Whatever navigational system is used, it is certain that in the future its indications will be passed automatically from the aircraft to Air Traffic Control. This will permit position to be indicated continuously to the controller and also facilitate identification.

The method of transmitting the data will be by a transponder system, which will operate either on demand or continuously from interrogation signals from the surveillance radar or a special transmitter. The information received by ATC will be fed directly into computers which will instantaneously and continuously assess the traffic situation, and pass instructions to the aircraft via a two-way link. Various methods of presenting instructions to the pilot have been suggested, among them pointers indicating on concentric scales on the gyro compass, altimeter and ASI, and driven by signals from the transponder; this would keep the instrument panel uncomplicated.

It would seem that a PPI radar will always remain indispensable as a monitor for ATC but that some interesting changes in displays are likely. Advances in fixed coil techniques will enable echoes to appear, not as dots on the screen, but as symbols or letters, originated by coded signals from the aircraft transponder. Multicoloured tubes, now available, will also permit of classifying different types of aircraft and greatly facilitate the controller's task.

With the development of the transponder concept, a revolution in flight plan filing can be brought about. When the flight plan is filed, details are fed into a computer, and a punched card is produced. The pilot inserts this into a unit in the cockpit, and all avionic operations connected with the equipment are programmed. The correct VHF frequencies to be used are selected at the appropriate stages of the flight, the transponder is coded with the aircraft symbol, and the navigational system is set up. During the flight the correct beacons are selected, charts are changed, and in the final stages of the flight the landing system is switched on.

Throughout the flight, the flight plan can be compared with the actual progress, and the pilot can be informed, by simple instrumentation, whether he is ahead or behind ETA.

Here it should be emphasized that the techniques to achieve this result are not complicated and are in use today in industry, and that the airborne equipment to make it possible would not be heavy or of excessively large dimensions.

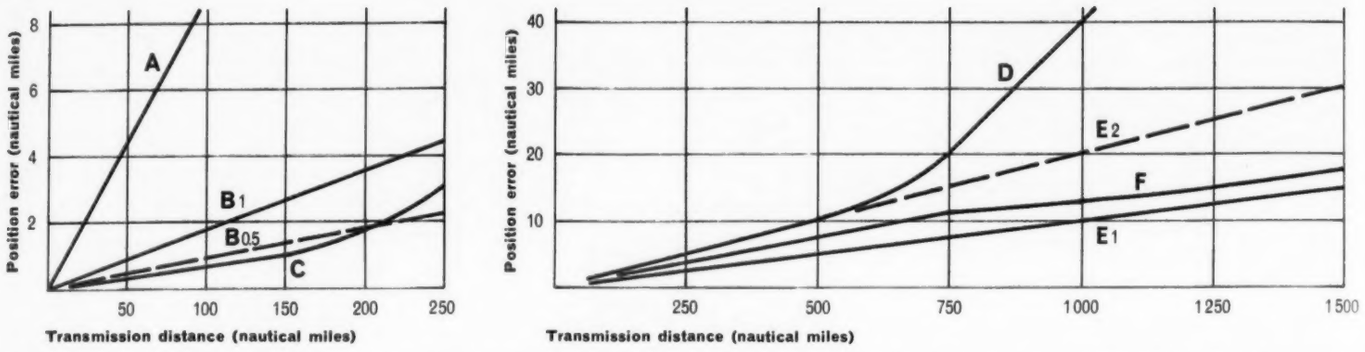


Fig. 3. Accuracy of various navigation systems; short-distance systems left, long-distance systems right. The abscissa show the transmission range, the ordinates the position errors to be expected in 95 percent of all cases. *Left:* A – VOR/DMET with plus/minus 5 degrees azimuth accuracy; B_1 – primary radar with 1 degree beam width; $B_{0.5}$ – primary radar with 0.5 degree beam width; C – Decca Navigator Mark 10. *Right:* D – Loran system; E_1 – doppler radar with uninterrupted reception, error 1% of the distance covered; E_2 – doppler radar with breaks in readings, error 2% of distance covered; F – Dectra system with distance measuring.

It is becoming apparent that, as traffic increases in density, some form of ATC on a global basis will be required in the interests of safety and collision avoidance, and that the long-range system will need the same order of accuracy as is obtained today from its short-range counterparts.

At present three main systems are being used, Loran, Doppler and Dectra. Their relative accuracies are shown in *Fig. 3.* Loran, which has given good service over a number of years, must eventually be superseded by methods which provide the instantaneous information needed in jet operations.

The Dectra system is probably the most promising radio fixing method available today for long-range operation and has the advantage of being able to provide, through the medium of its pictorial display, instantaneous information to the pilot.

The Doppler system, which is self-contained, is showing itself to be a valuable system and through the medium of a computer can indicate continuously ground speed and drift. It is normally capable of operating well over land, sea and ice, but non-reflection from calm sea can cause a discontinuity of information. In these circumstances, which can be for periods of up to 30 minutes or more, memory devices are brought into service, which operate from the most recent integrated information. The method can obviously introduce errors, and developments are now being carried out to ensure the continuity of positive information. Under operational conditions a Doppler system is generally accepted as providing an accuracy of position fixing to within one or two percent of the distance flown.

One method of improving accuracy in long distance navigation has been to combine Dectra and Doppler in the DIAN system, and the combination appears to be acceptable if it is considered that the weight penalty of a unit combining the two systems is equal to about the weight of fuel used in a jet aircraft for one minute's level cruising flight. Such a solution may be imperative for the North Atlantic route where traffic density is ever increasing.

For routes over uninhabited regions, where there are difficulties involved in operating ground based systems, the autonomous aids such as the Doppler and inertial systems would seem to be the ideal solutions, particularly if combined, although it is possible that the inertial systems may be perfected to a point where they provide continuous information unaided. If a comparison is to be made between the two principles, it should be recollected that with Doppler the system measures velocity directly and integrates once to obtain position, whereas the inertial system involves two integrations. Both systems are only as accurate as their associated compass reference. Looking into the future, an improved electronic reference derived from the radiations from selected stars may be developed for civil aviation.

*

It seems somewhat illogical that the fundamental problem affecting the operation of air transport—reliable all-weather schedules—is not yet solved, in spite of the great effort which has been made in the development of communications and navigational systems for aircraft. Nor does it seem that it will be solved for the next decade, since the ICAO standard Instrument Landing System is scheduled to continue until 1970 and is still being implemented, although the system in its present form does not permit landing in extreme reduced visibility conditions. Should not more effort have been put into landing systems at an earlier stage?

There are now indications of a determined effort to produce a truly blind landing system, and the emphasis has rightly been placed upon an integrated automatic system. Nevertheless, it is questionable whether such a revolutionary transition in methods should not be preceded by an interim pilot-controlled system of equal safety but of less complication and less cost. To the technician acquainted with the latest radar techniques and performance, there seems to be a place for a radar system with accurate DME, extremely narrow beamwidth and hence localizer accuracy. This, automatically linked with a radio altimeter, could provide an accurate localizer and glide path indication and, by integrated inputs, produce guidance throughout all the phases of a landing operation.

A system of this type has much to recommend it, and if its indications to the pilot are in the form of simulated Cummings or Calvert lighting it would enable pilots to be trained simultaneously for night and blind landing conditions, with a common form of indication instead of the three distinct systems which he must ultimately be trained to use.

*

In recent years much thought has been given to collision warning devices for aircraft, but to date no acceptable solution to the problem has been proposed.

The electronic technician's solution is to perfect the ATC, and to place the responsibility for safety on the ground, where expertly maintained computers, continuously fed with information from aircraft, would assess the situation continuously, and automatically instruct aircraft of the action to take to maintain a smooth flow of traffic and avoid danger. Even with today's short distance navigational systems these computers could supply ATC, via a data link, with information covering a radius of at least 200 miles. With long range navigational aids, they could report automatically throughout an Atlantic flight. Could this method not provide all the data needed for safety in the air, and could the automatic ATC not exercise a rigid discipline electronically, far more effectively than an anti-collision device which may have had a second-rate service inspection at some remote base prior to take-off? And would not air transport operators prefer to rely for safety on highly accurate navigational systems and on the circuits of a duplicated reliable computer, rather than on a heavy and expensive airborne radar? The answers must in each case be in favour of a perfected ATC, and technicians hope that they will be called upon to perfect such a system, rather than dissipate their ingenuity in attempting to create airborne radar anti-collision apparatus of dubious value to safety in the air.

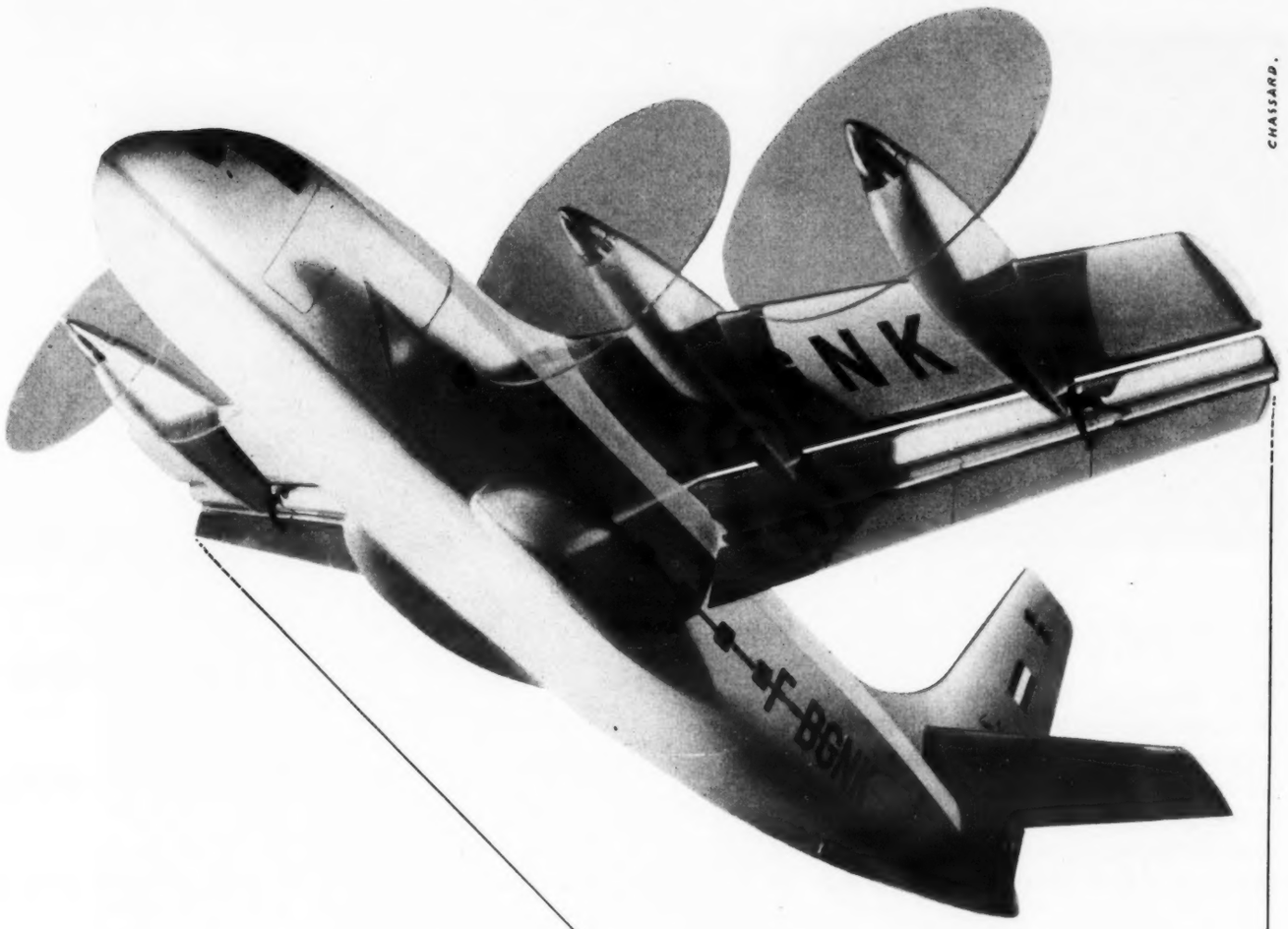
*

Generally speaking, the systems which have been developed over the past 15 years for both aeronautical communication and guidance are basically sound and are capable of further development to suit the requirements of the next decade. This fact must be recognized by aviation authorities, and it would indeed be regrettable and very costly if they were abandoned in favour of new systems before having the chance to reach their full potential development. The adaptations and modifications of the present systems must be towards integrating them with two-way data links between aircraft and ground and generally towards automation.

These developments will ultimately facilitate the pilot's task, render ATC nearly foolproof and ultimately result in considerable economic benefits to aviation authorities and airline operators.

Automation will call for a more highly skilled technical maintenance staff, but could mean reductions in the number of operational staff required in an ATC system.

Electronic technicians are confident that they can, with encouragement and if given full specifications of requirements, produce avionic and corresponding ground-based equipment which can give airlines a much improved safety factor and enable them to operate schedules with a one hundred percent regularity. Their hope is that the opportunity to do so will be given to them.



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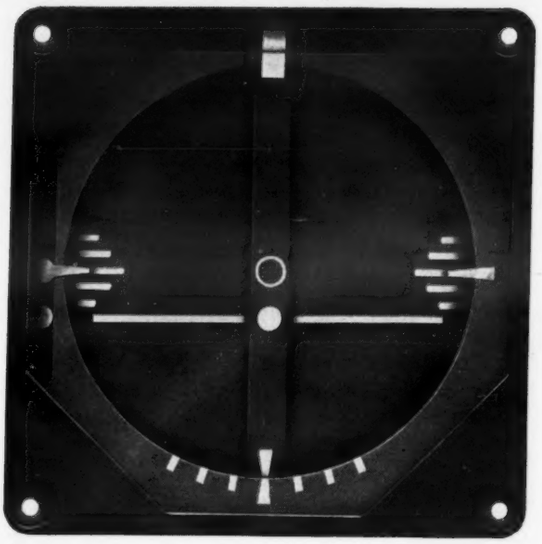

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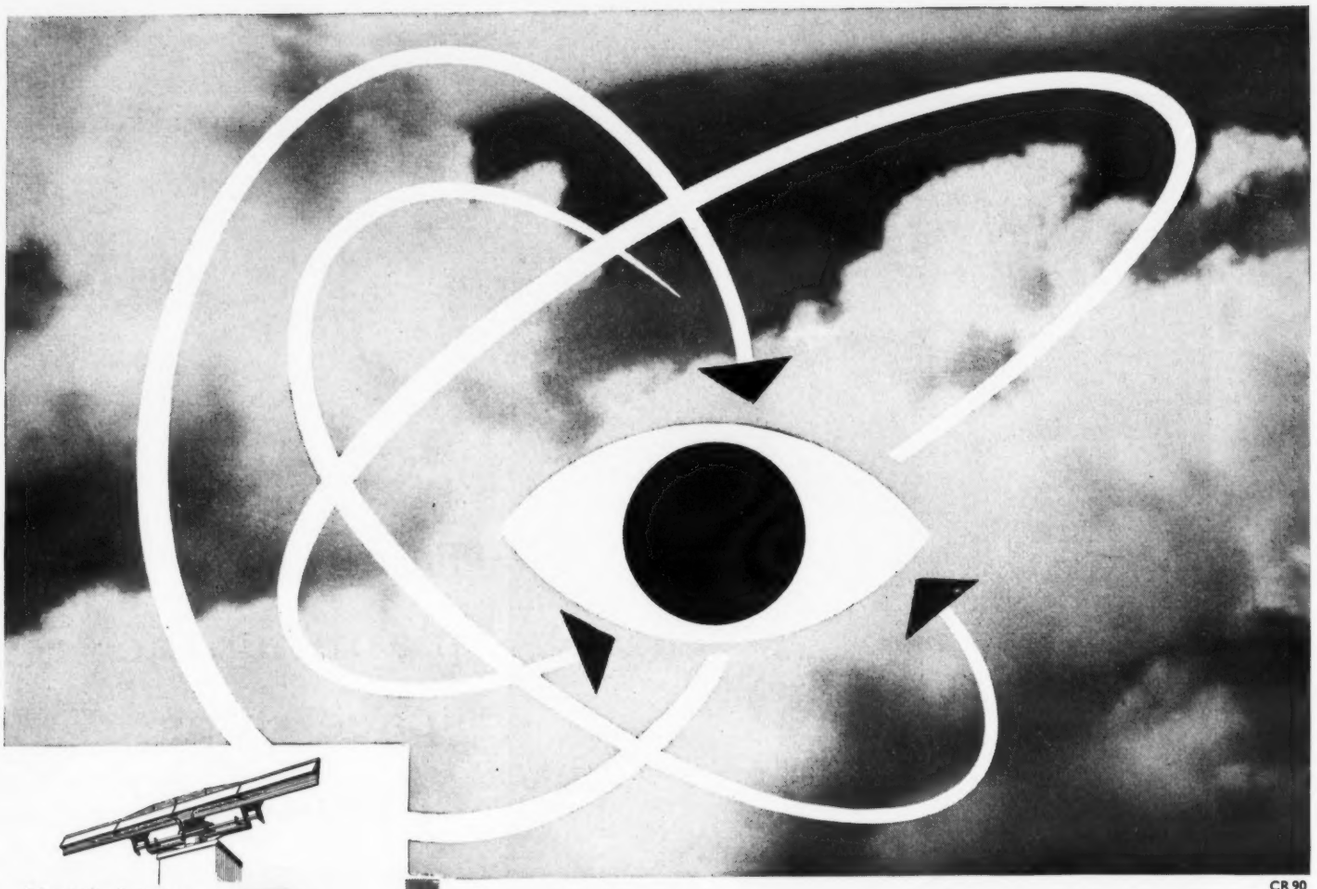

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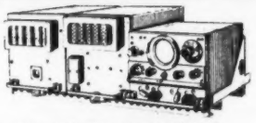

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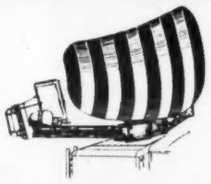
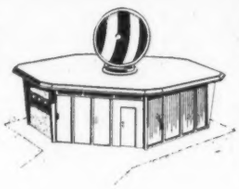


The CR 787 S-Band Airfield Control Radar. A high-performance primary radar with MTI and circular polarisation.



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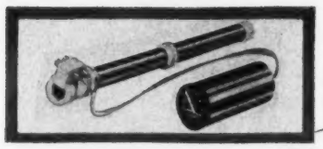

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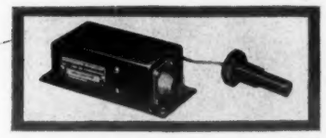

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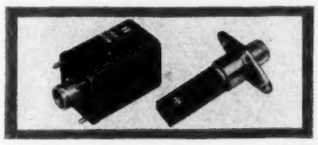

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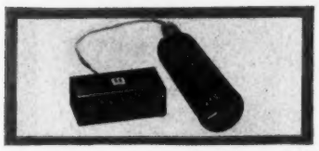

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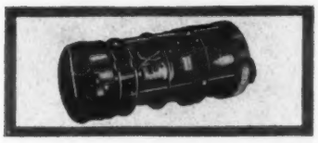

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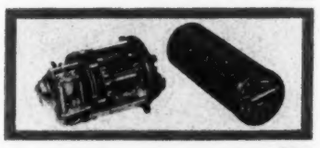

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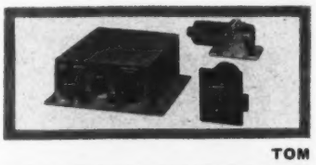

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Silicon transistors provide maximum reliability. Weight, including aerials, is approximately 18 lb.

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In an economy class layout the Super VC10 can carry up to 212 passengers plus 4 tons of freight non-stop from London to New York even against strong headwinds.

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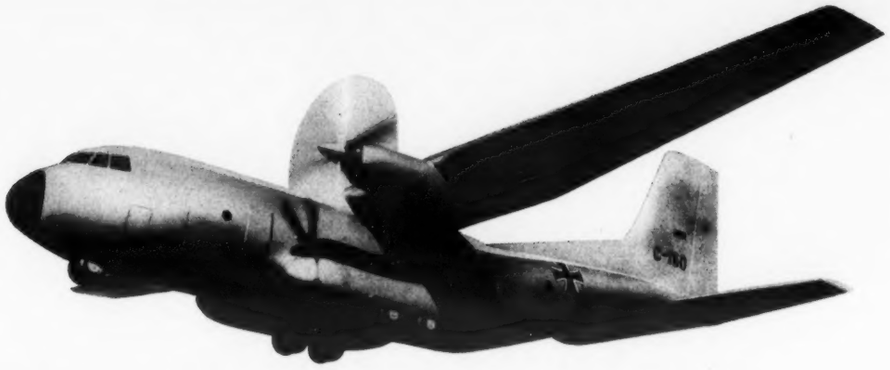
A Telling Example of International Cooperation



The Transall C.160

This is doubtless the first time that several countries have worked in common on the development of a larger aircraft, that they have from the outset sat down together to agree upon all the detail questions concerning this development and that two prototypes of the same aircraft have been built in two different countries. France and the Federal German Republic are the prime movers in this unusual project and have jointly—after discussing the specifications with Italy—prepared for manufacture of a common military transport, which has been given the designation Transall C.160 and is destined for the Western European air forces.

The remarkable history of this aircraft began in 1957, when France's Nord-Aviation and Germany's Hamburger Flugzeugbau, Weser Flugzeugbau and Blume independently began studies for a military transport. At that time it had already occurred to the defence ministries of both countries that an aircraft of this category should be developed jointly, in consultation with Italy.[1]

Differing requirements...

In preparing the initial specifications, both French and German planners based their thinking on practical wartime experience. The Germans took their lessons from their operations on the eastern front during World War II, while the French were thinking primarily in terms of an aircraft which would improve the transport facilities between France and Algeria.

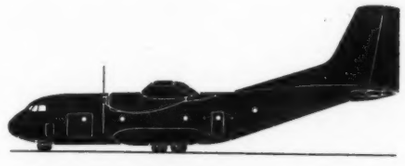
It is therefore not surprising that the two original projects should have differed considerably. In the German view, a transport of this class should have a penetration depth of not more than some 460 miles with a military payload of around 8 tons. Take-off run was to be as short as possible. In the overload case, it should be able to carry 15 tons, with a correspondingly longer take-off run. A pressure cabin was not considered necessary.

The distance between metropolitan France and Algeria led the French, on the other hand, to specify a penetration depth of at least 750 miles, and the considerably longer range, or to be more exact the higher altitude which this required, meant that the whole cabin must be pressurized. Max. range would be approximately 2,800 miles.

In December 1958 a systematic comparison was made, in the presence of Italian military experts, of the French and German projects. All the French projects were for a twin-engine layout, whereas the Germans presented both a twin-engine and a four-engine design. On January 28th, 1959, a conference of industry representatives opened, with the object of outlining the basic principles of the planned cooperative development programme, and this date is considered as the date of foundation of the *Transall Working Group*.

... reduced to a common denominator

The two governments decided to share development costs equally between them, and work was divided on a similar basis, with 50 percent going to the French companies (Nord-Aviation and Messier) and 50 percent to the German group (Weser



Main data for the Transall C.160

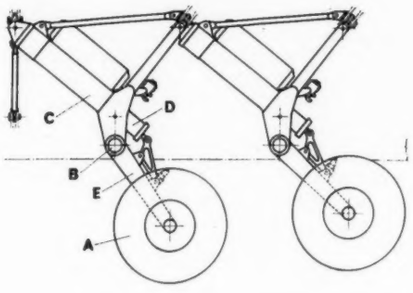
Applications: Transport of supplies or troops, parachute dropping of men and materials, and ambulance services.

Dimensions	
Length	102 ft 0 in.
Span	131 ft 3 in.
Tailplane span	47 ft 7 in.
Overall height	38 ft 6 in.
Wing area	1,722 sq.ft.
Aspect ratio	10
Dimensions of hold	
Useful length	42 ft 7 3/4 in.
Useful width	10 ft 4 in.
Useful height	9 ft 9 1/4 in.
Powerplant	
2 Rolls-Royce *Tyne R.Ty.20* turboprops	of 5,590 s.h.p. each or 6,020 e.h.p. each
Propellers, de Havilland four-blade, diameter 18 ft.	
Undercarriage	
Track	16 ft 8 3/4 in.
Tyre pressure	42.7 p.s.i.
Weights	
Normal gross weight	~90,400 lb
Max. gross weight	99,000 lb
Normal payload	17,640 lb
Max. payload	30,800 lb
Performance	
Cruising speed at 26,250 ft	270 knots
Range	2,800 miles
Take-off distance to 32.8 ft	1,970 ft
Landing distance from 32.8 ft	1,970 ft

[1] Weser Flugzeugbau, Hamburger Flugzeugbau and Siebelwerke have already worked in close cooperation with Nord-Aviation, whose Noratlas 2501 is being constructed under licence by the three German companies.

Flugzeugbau, Hamburger Flugzeugbau and Blume Leichtbau).

Next, a group of experts spent several weeks on settling the essential features of the planned transport. The result was a design with high-set wing, two turboprops in the 5,000 h.p. power class, a pressurized fuselage with rear loading door and heavy-duty eight-wheel main undercarriage in tandem. According to a German proposal, the hold cross section was to coincide with that of the international railway waggon, and the wing, with an aspect ratio of 10, met both French and German ideas.



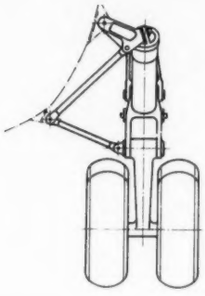


Fig. 1: Diagram of the Messier main undercarriage: each twin wheel (A) is independently sprung and swivels only about axle (B). A single hydraulic jack (C) provides undercarriage operation (retraction and lowering) and shock absorption. Piston (D) is mechanically locked in various positions inside the jack, so that the swivel arm (E) and twin wheels can be set in the desired position—retracted, half retracted, fully lowered (cf. *Fig. 2*). The triangular supporting framework for each pair of wheels, formed by the jack and a number of struts, thus remains rigidly connected to the fuselage bulkhead. This interesting design is not only noteworthy for its rugged and simple structure, but also enables optimum shock absorption to be obtained at the same time as minimum weight.

A preliminary agreement was signed between the two governments in mid-December 1959, laying down the principles of further cooperation and general directives for distribution of the development and production programme. Under this agreement, Weser Flugzeugbau GmbH, of Bremen, acts as "pilot" firm for the Transall project and is also responsible for the fuselage centre section. Hamburger Flugzeugbau GmbH will supply the forward and aft fuselage sections, Blume Leichtbau and Flugtechnik GmbH, of Duisburg—a pure development company—will design the tail unit, while Nord-Aviation contributes the wing and wing attachments, plus the engine mountings and certain items of equipment. The undercarriage with its ten low-pressure tyres will come from Messier.

A joint design group provided by all three German companies is at work at Weser Flugzeugbau. Each of the participating companies works in its own facilities, and there is a joint coordination team in Bremen. Representatives from the companies mentioned have formed a technical directorate of eight members (one main representative and one deputy from each company), which meets once a month; members are Calvy and Faucon (Nord-Aviation), Bansemir and Schrecker (Weser Flugzeugbau), Pohlmann and Wocke (Hamburger Flugzeugbau) and Liebing and Rebeski (Blume). In addition there is a permanent committee comprising one expert from each company, which meets twice weekly at Lemwerder. Finally, the widespread geographical distribution of the various design and development offices has necessitated the creation of separate technical working committees for each of the main sub-assemblies; these have performed useful coordination work during the past year.

The difficulties...

The difficulties facing such an international project can be imagined: financing, the question of currencies to be used for accounting purposes, the handling of sales taxes and customs charges all presented considerable problems. A financing plan providing for quarterly settlements was prepared and appears to have proved successful. By the end of 1959 a total of roughly 6 million D-Marks had been expended; the present estimate for total cost of development and the construction of three prototypes and of test airframes is 95 million D-Marks. The first aircraft is being built in France and will probably begin flight testing in 1962.

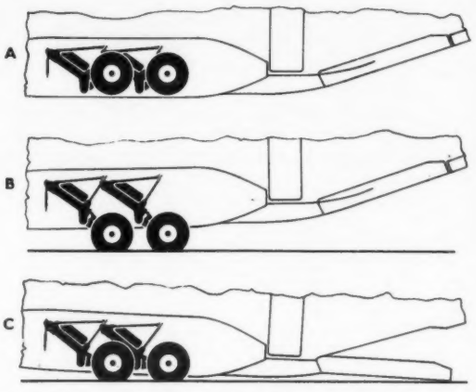
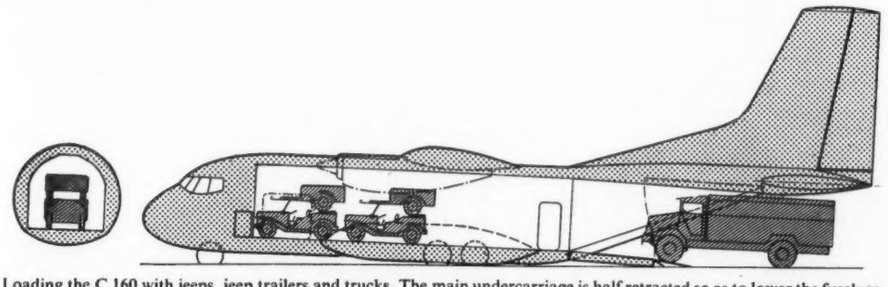
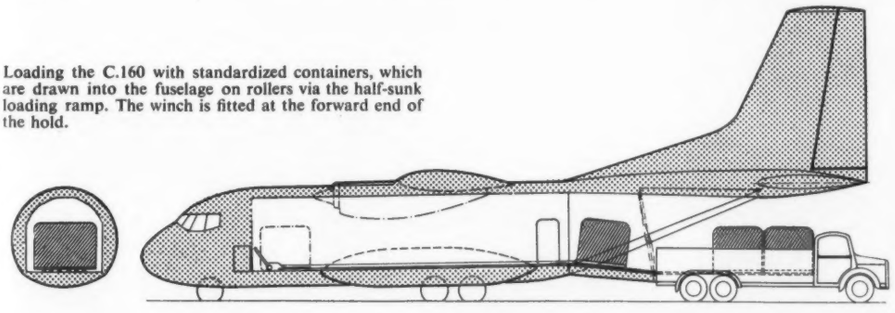


Fig. 2: The three positions of the Messier undercarriage. A. retracted; B. fully lowered (for take-off, landing and taxying); C. half retracted (for loading and unloading).

One small example of the difficulties encountered in the design of the transport is the question of agreeing upon standards for rivets and screws. Agreement was reached, but naturally also necessitated the introduction of standardized tools (screw drivers, etc.). This of course was facilitated by the fact that all the companies concerned in any case use the metric system, and all state that the best solution was adopted in each and every case.



Loading the C.160 with jeeps, jeep trailers and trucks. The main undercarriage is half retracted so as to lower the fuselage rear.



Loading the C.160 with standardized containers, which are drawn into the fuselage on rollers via the half-sunk loading ramp. The winch is fitted at the forward end of the hold.

... and the solution

It is still not possible to publish full information on structural details of the C.160. However, the most important features are outlined below, with discussion of detail where possible. The C.160 airframe has been designed for a safe load factor of three and is of entirely conventional structure, to ensure

optimum operational reliability. The design of the fuselage is based on the need for rapid loading and unloading. A winch and roller system facilitates the handling of heavy loads. The three-part wing is of monocoque construction, with integral fuel tanks. The wing joints lie outside the engine nacelles. All the main sub-assemblies in the airframe are exchangeable, and special measures have been taken to ensure that particularly vulnerable parts can be rapidly replaced. The wing trailing edge carries double slotted flaps extending over almost the whole span; the relatively small ailerons are backed up by spoilers. Air brakes, retracted into the wing, are provided to brake the landing and for use in certain flight manœuvres. The structure of the Messier undercarriage, which is designed for operation from semi-prepared airfields, can be seen from the accompanying drawings.

Wing and tail leading edges, and engine intakes and propeller hubs are de-iced by a Napier Spraymat installation. The pressurization system for the fuselage comes from Normalair.

Key point: the engines

The choice of a twin-engine layout for a transport in the 40-ton weight class was based on use of the Rolls-Royce *Tyne* turboprop, which in the RTy.20 version has a power of 5,590 s.h.p. and of 6,020 e.h.p. In the early days there was considerable discussion about the number of engines to be used, but both French and Germans agreed that preference should be given to the twin-engine formula. With the *Tyne 20*, the C.160 meets all CAR requirements for failure of one engine during take-off. Even from makeshift runways the aircraft should be able —after unloading its cargo at destination— to take off on one engine. However, the advisability was considered of fitting the aircraft with two auxiliary jets (thrust class 3,300 to 4,400 lb) beneath the outer wings for certain operations. In this connection mention has recently been made of the Pratt & Whitney JT12 jet, which—if a major order is placed—will be manufactured under licence for the European market by France's SNECMA.

As regards the *Tyne* main engine, the French and British governments have recently agreed in principle that it should be manufactured under licence by Hispano Suiza in France. It is reportedly planned that Rolls-Royce should supply some 20 percent of the *Tyne* components to the French company. It is also possible that Belgium's Fabrique Nationale d'Armes de Guerre and Germany's MAN engine plant may at a later date participate in the production of *Tyne* components. Incidentally, it will be recalled that NATO's Breguet 1150 *Atlantic* maritime reconnaissance aircraft also has *Tyne* engines.

Technical details of the Transall are given in the accompanying box. At max. gross weight (approx. 99,000 lb) the C.160 will have a range of 2,800 miles; for shorter ranges gross weight is roughly 90,400 lbs.

If the flight testing, scheduled to begin in 1962, is successful, and if France and West Germany—and possibly other countries— order the C.160 as standard military transport for tactical missions, then the painstaking preparatory work on this unusual aircraft project will have borne its fruits.

Pilot Training on a Leash

A New Helicopter Simulator

In the epic days of flying, "aviators" learnt from their own errors how to move in an element not originally intended for man. Later, the instructor taught his pupils the rudimentary notions of flying before wishing them luck and sending them on their way. Today, even in fine weather, part of the training takes place in the class-room, thus saving not only time and money, but also crashes.

As a helicopter pilot's training is particularly time-consuming and expensive, all possible methods and equipment have been tried out in an attempt to simplify training. The Bölkow *Heli-Trainer* is but one of these. Now, in Edmonton, Canada, engineers of Jaycopter Limited have developed a helicopter simulator which in many respects represents an improvement.

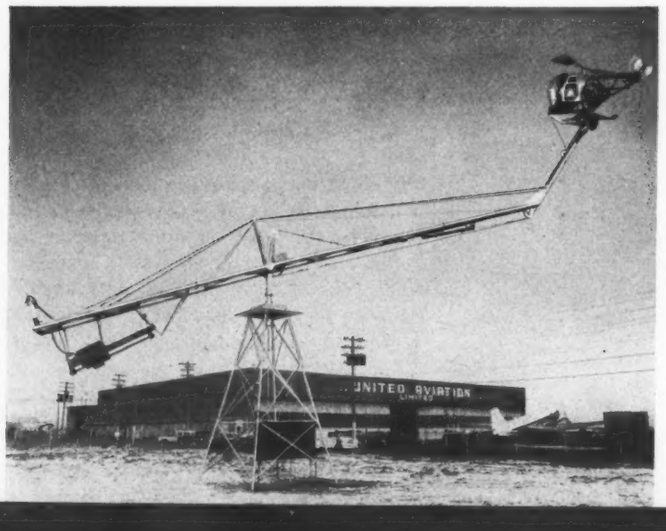
This device, known as the *Jaycopter*, is described as being "free-to-air," for the pupil has the feeling of being in an actual helicopter. This sensation is achieved by the "true-to-life" dual controls, instrumentation and seating arrangements and the characteristic rotor noise. As the simulator is powered electrically, the cabin is relatively quiet, so that the instructor can direct his pupil in a normal voice.

As the picture shows, the *Jaycopter's* fuselage is attached to one end of a boom resting on a four-legged tower; at the other end of the boom is a counterweight. By the actuation of a control on the instrument panel, the weights can be so displaced as to vary the load from zero to 250 lb. This is the maximum weight which can be lifted by the main rotor, and permits simulation of high altitude or heavy load flight.

Fore and aft balance is achieved by means of an electrically controlled weight which moves along the longitudinal axis of the fuselage and stops automatically when equilibrium is reached. When two occupants are of unequal weight or when one flies solo, port and starboard balance is effected by shifting the fuselage sideways until its centre of gravity is over the longitudinal axis. A ventilation and heating system permits training at high temperatures and at temperatures as low as —30° F. Cabin lighting is provided for night flying.

The *Jaycopter* can carry out all the manœuvres of a genuine helicopter, such as drags, flare turns, running autorotations, spiral descents, running take-offs and landings and transitional lift. It can even execute manœuvres that should not be performed in a conventional helicopter in high wind conditions.

The *Jaycopter* should be of inestimable service in the faster, cheaper and safer training of helicopter pilots.



The *Jaycopter* helicopter simulator. Transaero Inc., of Flushing, New York, is sales agent for the equipment in territories other than Canada and the USA.

Main powerplant: one 3 h.p. electric motor (220 V, single phase)	
Height of tower	25 ft
Length of boom	78 ft
Fuselage length	180 in.
Fuselage width	52 in.
Fuselage weight	900 lb
Useful load	500 lb
Main rotor diameter	120 in.
Main rotor speed	420 r.p.m.
Tail rotor diameter	38 in.
Tail rotor speed	1,450 r.p.m.
Pivot range	100 ft
Ceiling	78 ft
Rotation of fuselage	360°
Fuselage tilt	30°
Rotation of boom	360°
Max. rate of climb	500 ft/min

On Wings of Steel

New Materials and Manufacturing Processes for the Bristol T.188 Supersonic Research Aircraft

Britain's first Mach 3 aircraft, which is due to make its maiden flight before the end of the year, is a pure research aircraft, the Bristol T.188. Designed and built by the British Aircraft Corporation's Bristol Aircraft Limited at Filton, it will be powered by two afterburning de Havilland *Gyron Junior DGJ.10* jets with a maximum reheat static thrust of 14,000 lb, and is expected to reach speeds of between Mach 2.5 and 3 at altitude: span is 35 ft 1 in.; length 71 ft; wing area 396 sq.ft; thickness/chord ratio 4%; take-off weight . . . not revealed.[1]

Quite apart from its future aerodynamic and thermodynamic research tasks in the whole altitude and speed range, and its use as an experimental carrier of new airborne systems, this aircraft is already serving as a " guinea pig " during the construction phase, to try out high-grade steels never before used in aircraft manufacture. As large portions of the structure will reach temperatures of over 250° C during protracted supersonic flights, under the combined influence of aerodynamic surface heating and the heat given off by the engines and other systems, the use of aluminium alloys is clearly impossible, for strength and stiffness reasons. To replace the traditional light metals used in airframe construction, *Firth-Vickers Stainless Steels Limited* (together with its parent companies English Steel Corporation and Firth Brown) supplied a series of new semi-finished products, some of them of stainless steel, others of titanium-stabilized chrome nickel steel and others still of high-strength but low-alloy steel. In close cooperation with Bristol Aircraft, the company submitted these to extensive fabricating, mechanical, chemical and metallurgical tests. The following are examples of the products and the components for which they are used.

● **Plates and sheets**

Integrally stiffened parts of the T.188's surface, milled out of plates, and single curvature thin skin sheets are for the most part made of *FV.448* stainless steel, a complex 12% chromium steel originally developed as a creep-resisting material for gas turbines. If this material is heat treated to high strength conditions, it is impossible to stretch, but must be milled and ground. Thinner forms, however, can be manufactured by the normal hot and cold-rolling processes, with intermediate stretching to achieve flatness and, as the last stage, heat treatment in vertical ovens to the necessary hardness. Even in this case, milling and grinding are still sometimes necessary.

For double curvature parts a different steel alloy was chosen, namely Firth-Vickers' *FDP* chrome-nickel steel with 18% chromium, 9% nickel and some titanium. This alloy, whose physical properties are somewhat less satisfactory than those of FV.448, has good welding qualities and is easier to form. After forming it is heat-treated at 450° to 550°C.

● **Forgings**

The accompanying pictures reveal that the T.188's inner wing is extremely thin, so that the forces and moments arising in the outer wings have to be conducted around the two engines by means of solid steel cylinders. The centre portion of each engine nacelle consists of three machined forgings of FV.448 steel bolted together. Each raw forging (without internal grooves) weighs between 3 and 4 tons, which is then reduced to rather more than one ton once the grooves have been machined out . . . probably an unbeaten record weight for forgings in aircraft construction. In the final state the lightest of the three cylinders weighs only 171 lb, and the heaviest 270 lb.

FV.448 is also used for the keel boom, a complex angled forging almost 27 ft in length (rather longer in the raw state), with the thickness of the angle section varying between 0.45 and 0.1 in. For hardening, a tunnel furnace with spiral electrical heaters in the walls had to be constructed. Hydraulically operated clamps inside the furnace hold the bulky forging in place to avoid buckling. For tempering, the wall heaters are not used, the sole source of heat being the resistance-heating of the bar itself. The clamps are not released until the bar has cooled below critical temperature.

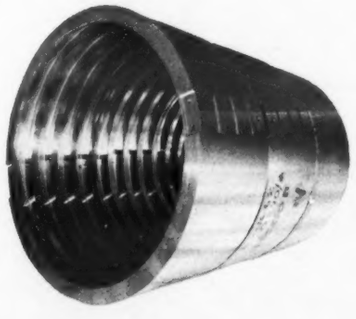
Besides FV.448, use is also made of a high-tensile steel generally similar in composition to EN.40C. One of the accompanying pictures shows a number of attachments for the outer wing made of this material, whose tensile strength is between 110 and 120 tons/sq.in.

*

Finally, almost all of the bolts in this aircraft are made of low-alloy Firth-Vickers steel with a tensile strength of 90 to 100 tons/sq.in., while quick-release fasteners are mainly of FV.448 bar material. The material chosen for the piping in the hydraulic system (for undercarriage, power controls, flaps, etc.) is austenitic stainless steel.

The experience of a number of special steels gained during prototype construction of this unusual aircraft led Firth-Vickers to develop two high strength stainless steels, known as *FV.520* and *FSM.1*. Though both are now available, they were perfected too late to be included in the first (and hitherto only) T.188.

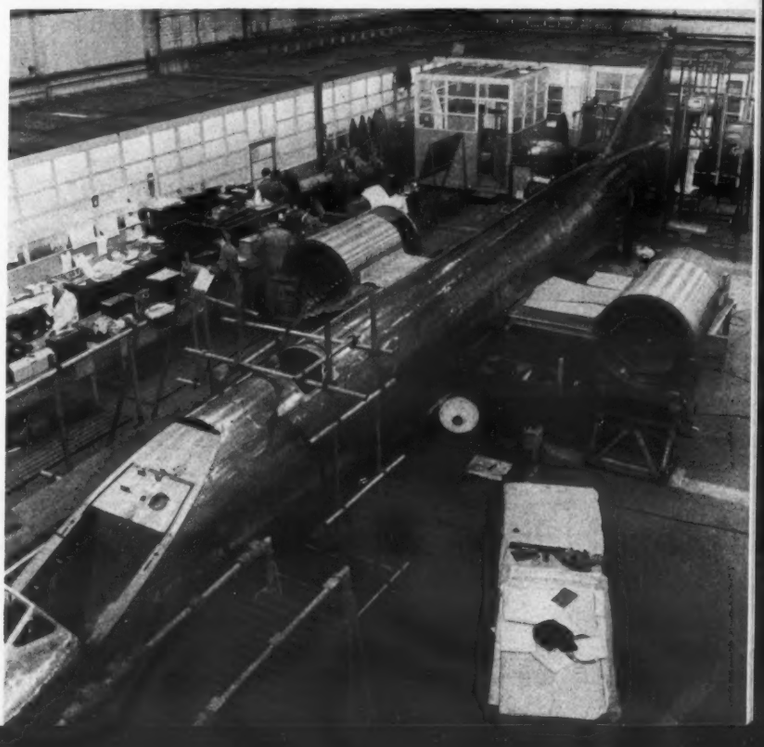
[1] For further information, in particular on the wing planform and engine arrangement, see *Interavia* No. 1, 1960, p. 102.



Each engine nacelle consists of three solid cylinders of stainless steel (FV.448) bolted together; total weight around 650 lb. This unusually rugged structure is required to conduct the forces and moments from the outer wings around the two engines.

Group of ultra-high-tensile wing attachment forgings.

The Bristol T.188 fuselage under construction at Filton. The steel cylinders are already in place.



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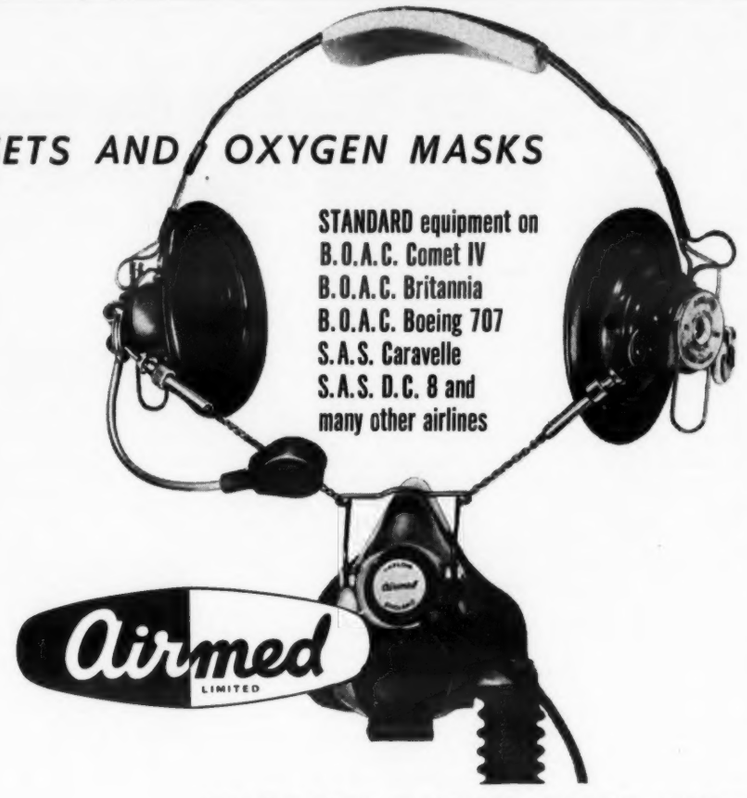

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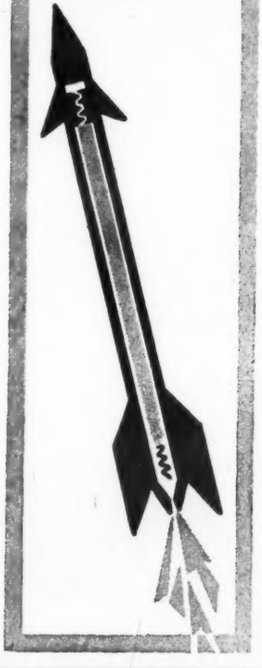

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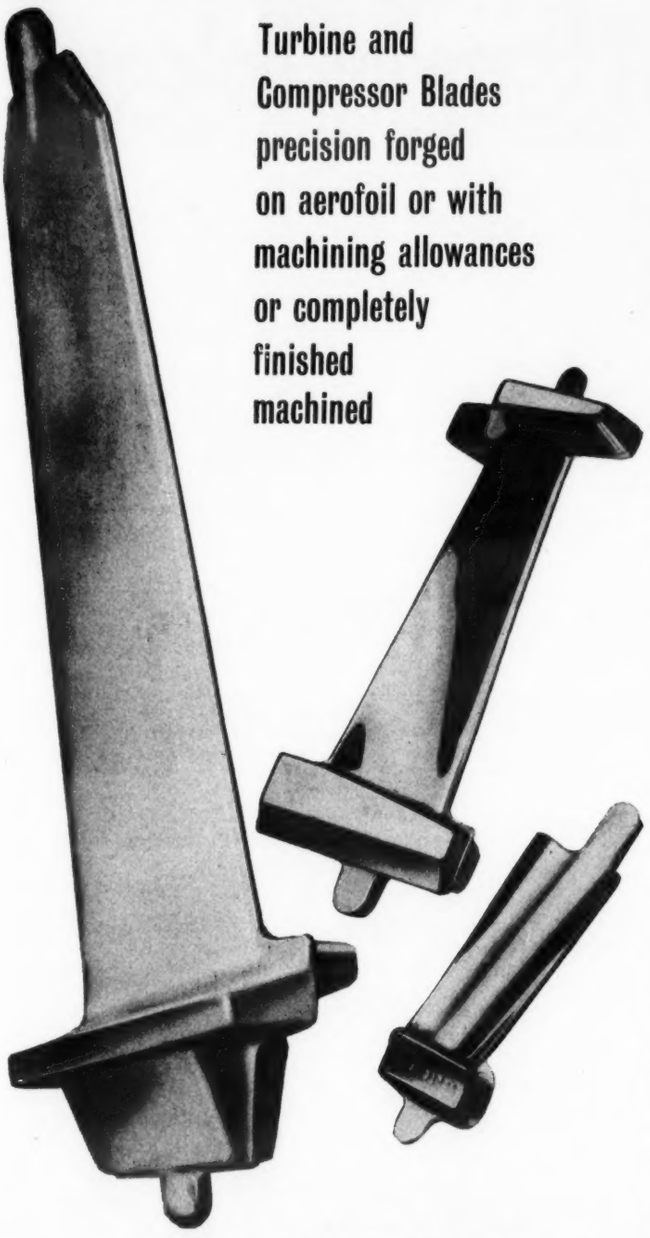

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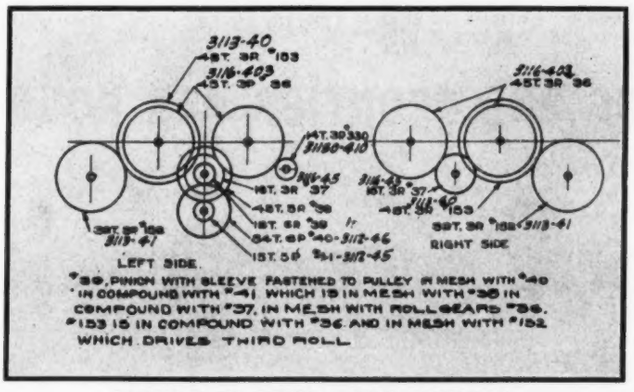
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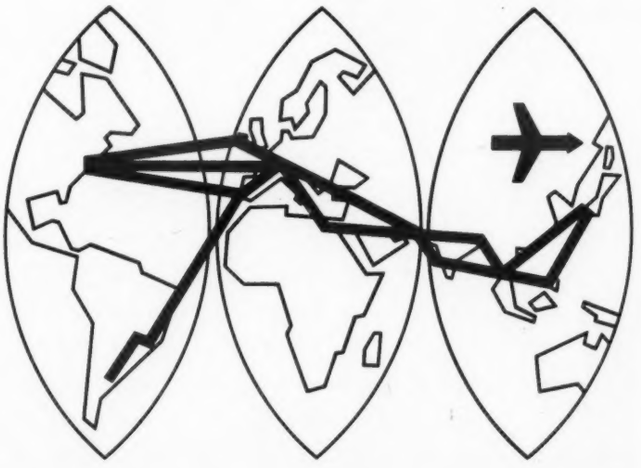

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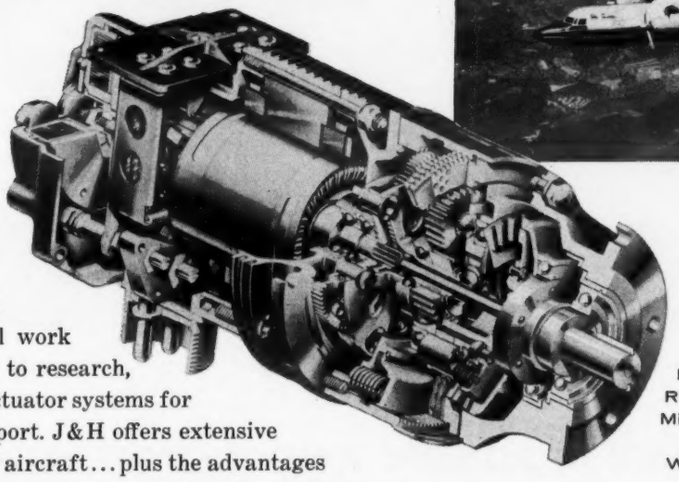

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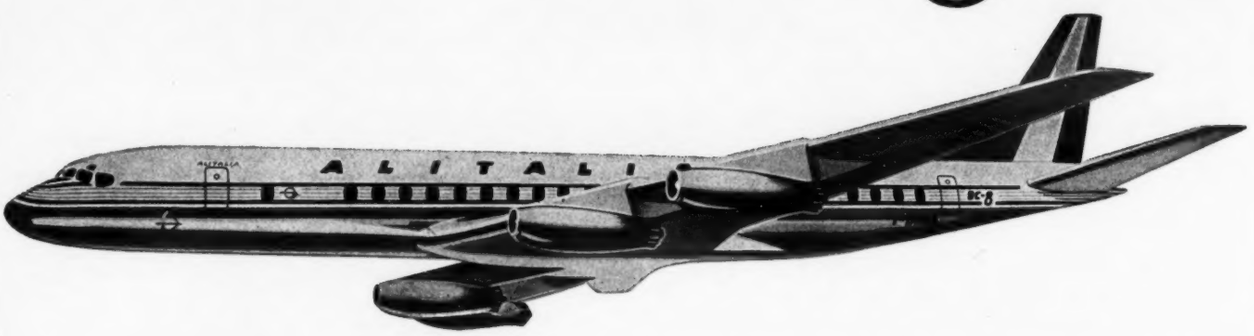

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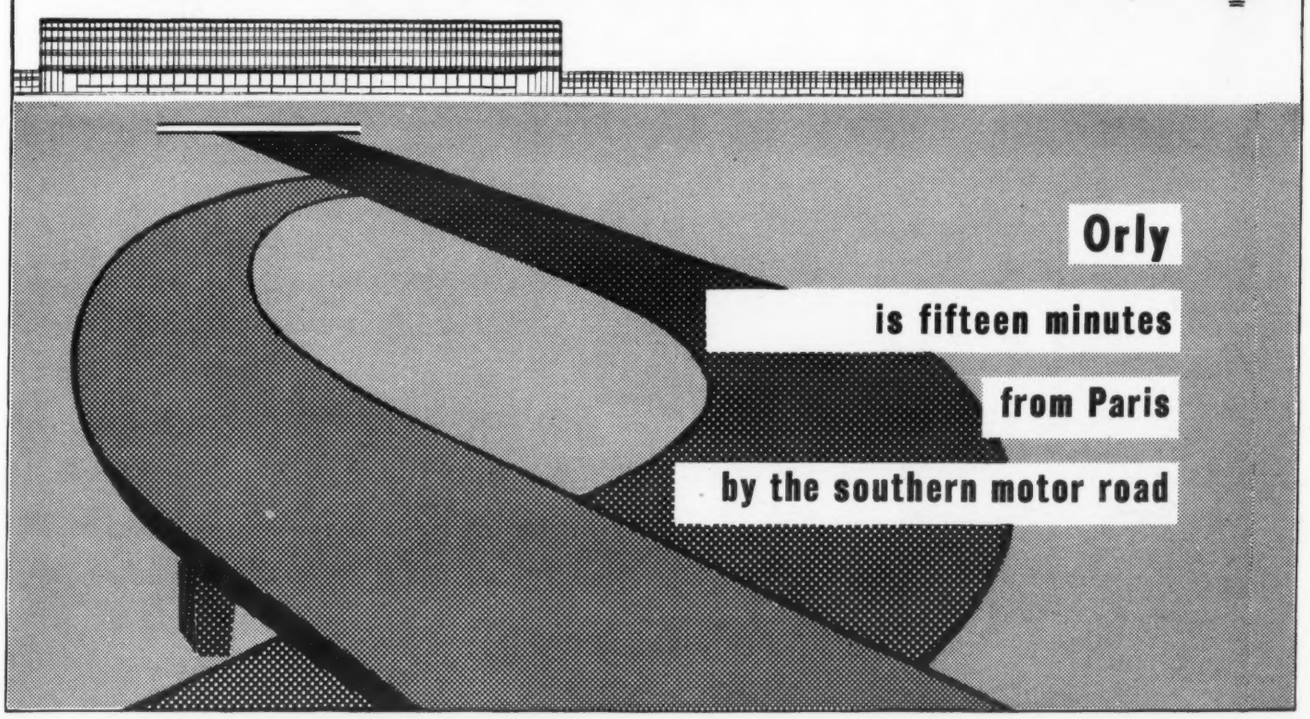

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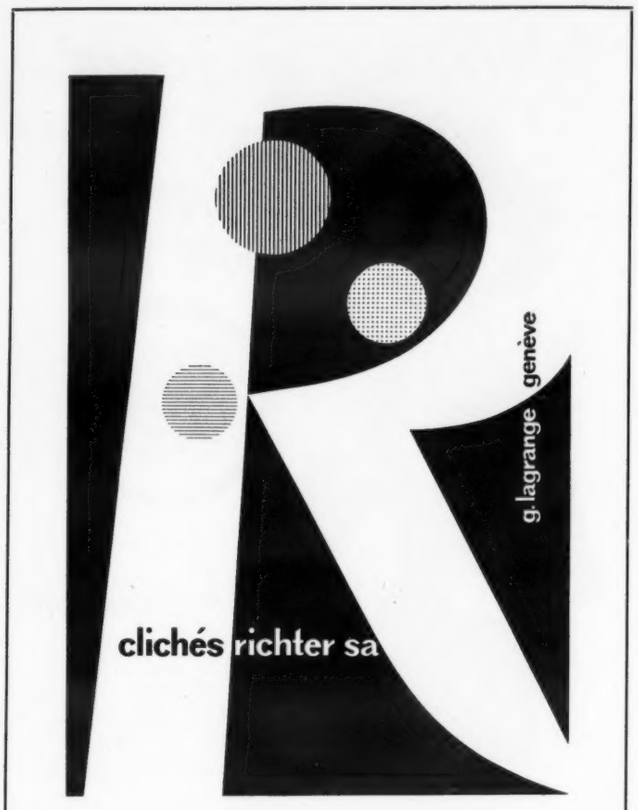

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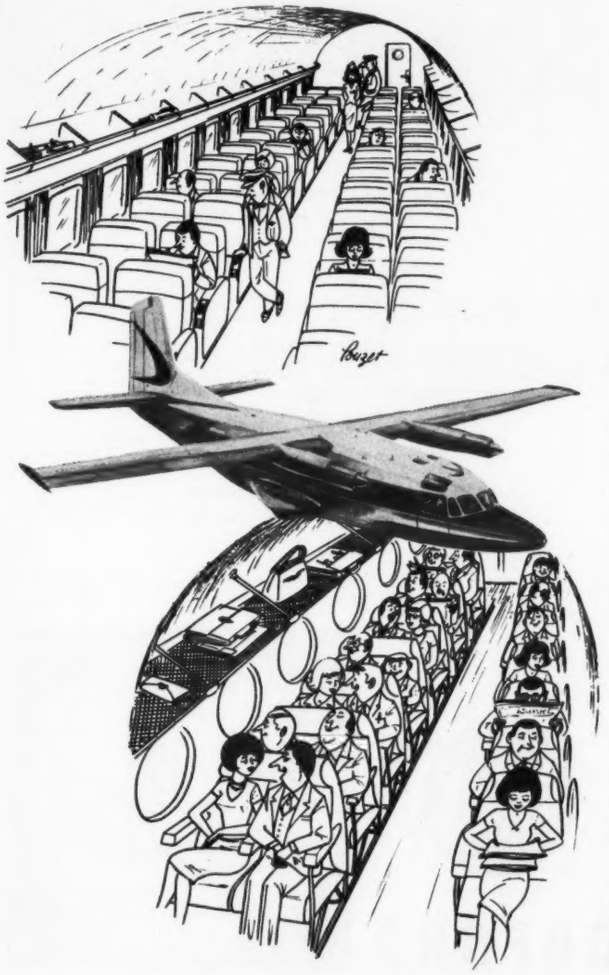

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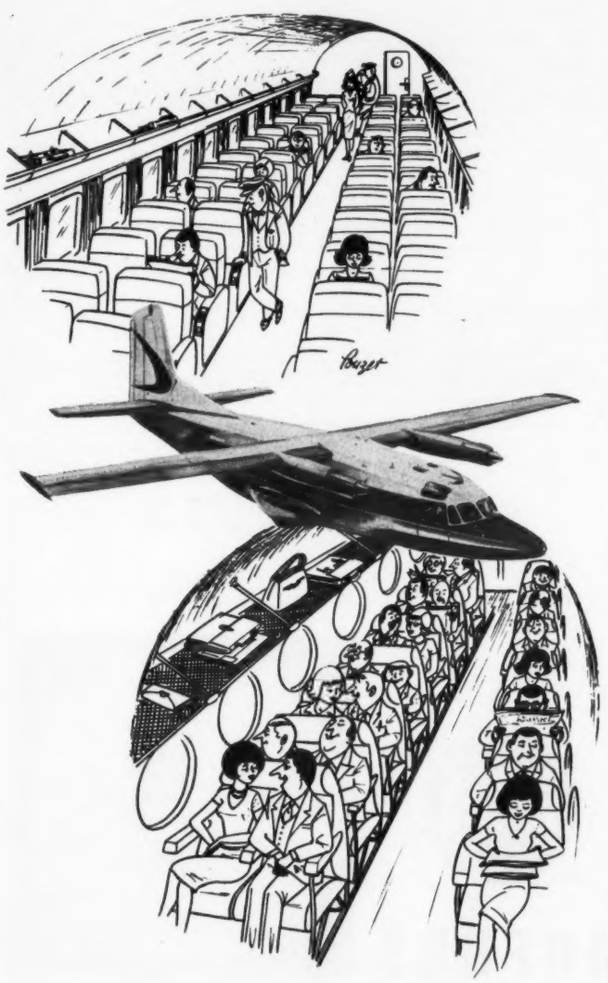

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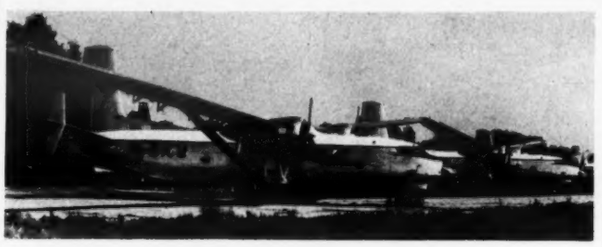

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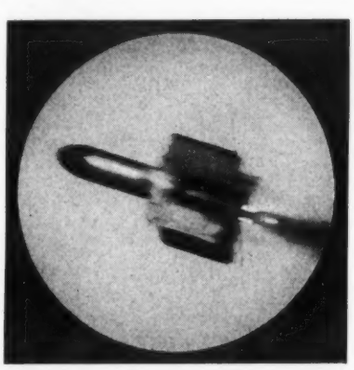

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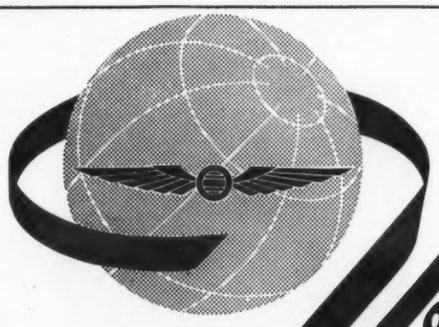

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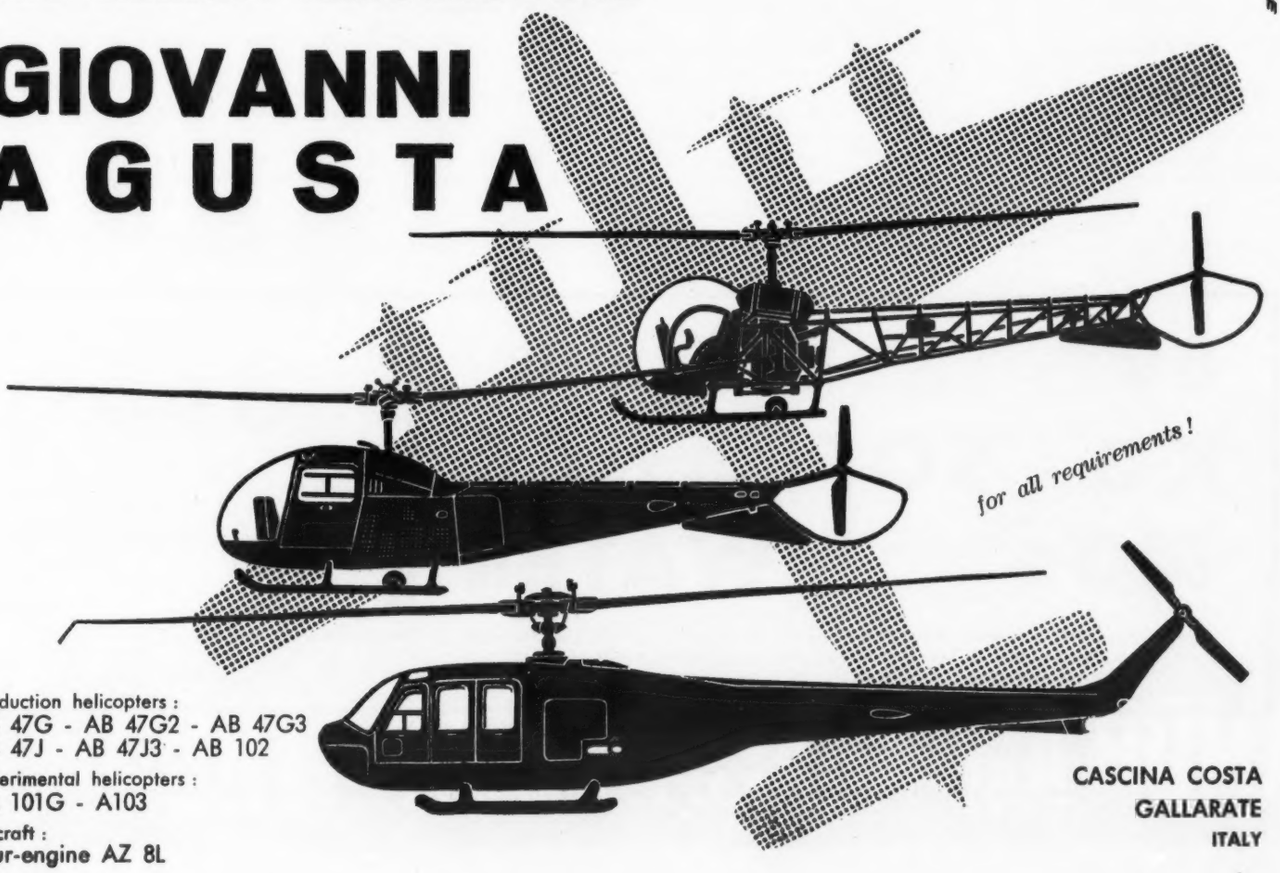

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Cover, four colour printing and photogravure: Fabag Druck Zurich • Letterpress printing: Imprimerie de la Tribune de Genève
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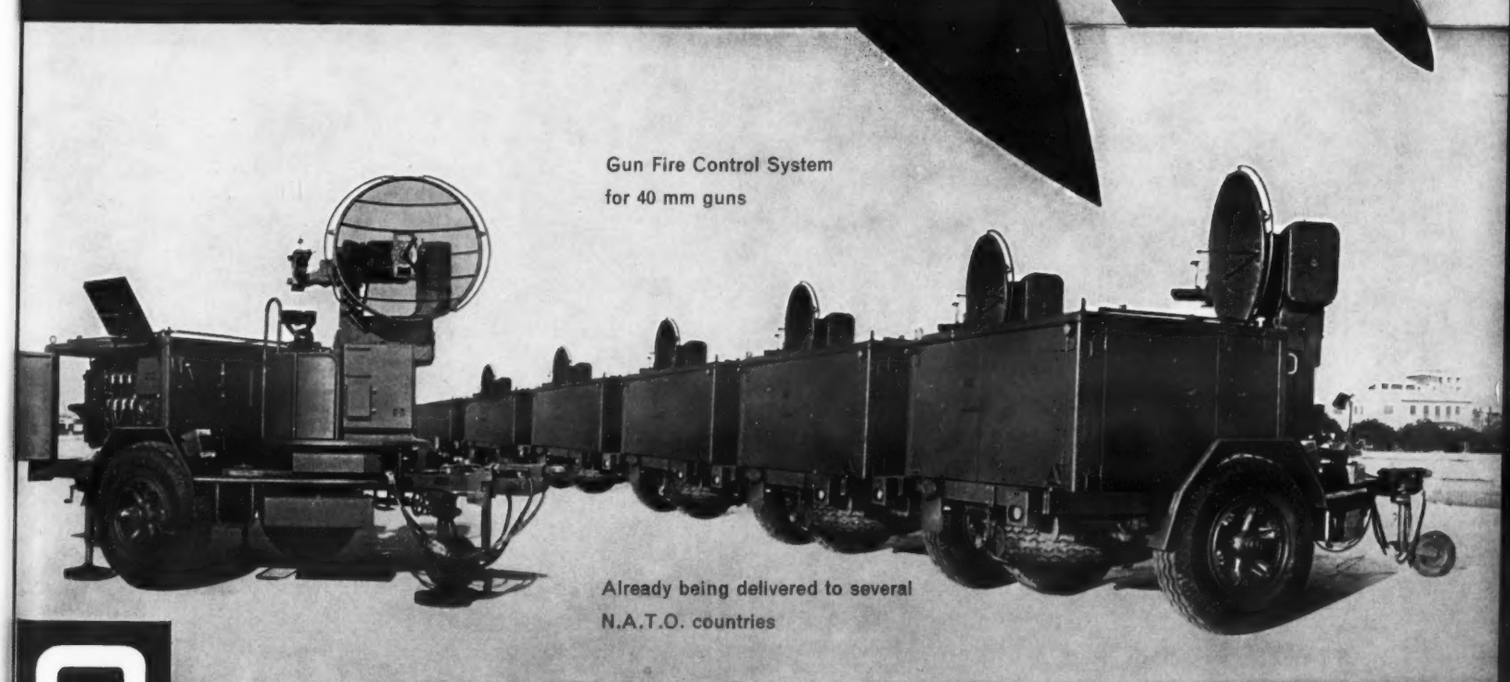

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